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Editorial Comments.

THE PORTS OF RUMANIA.

For many years the area of South Eastern Europe known as the Balkans, has been regarded in many quarters as being imbued with characteristics conflicting with the requirements and conduct of commerce. There is little that this unsympathetic attitude has been largely begotten of purely political prejudice and the myopia caused by the claims and counter-claims of the many races whose national homes are located in this region. Clearer perception appears to be prevailing, and with it a heightened recognition of the possibilities of development in the Balkans, with its raw material of economic wealth in the shape of oil, minerals and wheat.

Perhaps no country in Europe, with the probable exception of Russia, realised the possibilities of this region earlier and more acutely than did Germany, to whom the tapping of its resources formed part and parcel of the Mittel-Europa idea and its railways an inevitable link in a far-flung field of influence in the Near East. Since the World War, the Powers in Europe have ranked less in Balkan affairs than of old, and the heavy price which was paid for their pre-occupation with the old national rivalries of the Balkan States is likely to remain indelibly in the public memory for all time.

The vicissitudes of Austria-Hungary on the north of this area and the rapid rehabilitation of Czecho-Slovakia on the north-west, and the misgivings of Yugo-Slavia on the west are familiar events of post-War history. Perhaps of all the Balkan countries whose course of late years has been marked by serious efforts at reconstruction, Rumania may well claim pride of place. Ample evidence of this progressive movement more particularly in the sphere of ports and waterways is afforded by the articles on "The Ports of Rumania." There is little need to introduce the author to our readers. The U.S. Official Delegate to the XIV. International Navigation Congress at Cairo, in 1926, Commissioner MacElwee's name is well known in connection with the progress of Charleston, South Carolina, whilst his textbooks on port affairs enjoy a world-wide reputation.

Rumania, as will be seen from the Supplement, is a large country, the great mass of which lies due west of the Black Sea. Its coastline lends itself more to port development than that of any other country located on the shores of the Black Sea. To the South, separating it from Greece, is Bulgaria. On the south-west is Yugo-Slavia, bounded on the west by the Adriatic. Austria-Hungary flanks the north-west of Rumania and Czecho-Slovakia is located nor-north-west. Due north is Poland and the rich wheat lands of the Ukraine served by the Port of Odessa not a great many miles from the north-eastern frontier of Rumania.

The chief sea-port of Rumania, giving outlet to the Black Sea, is Constanza. The other great ports of the country, Galatz, Braila and Giurgiu are inland river ports grouped in the south-eastern portion of Rumania. The maritime littoral separating them from the coast is a comparatively narrow tract in relation to distances in the main land mass of the country as a whole. The predominant characteristic of the inland ports is that they are all located on the great international waterway, the River Danube. Galatz is the most northerly situated with Braila some little distance south at the junction of the River Pruth, a great northern tributary of the Danube; whilst Giurgiu is far away south on the Rumanian side of the Bulgarian frontier. A notable feature of the Danube is the delta, with its three channels, the Chilia, the Sulina and the St. George's flowing into the Black Sea and respectively marked by the ports of Valcov, Sulina and St. Georges.

The part played in the destiny of the Danubian ports is not a primitive geographical one, but is modified in a very considerable degree by the influence of the port and river authorities concerned, whose work is described in the first article, specifically devoted to Danubian navigation. Attention might incidentally be directed to a reference in the January issue to the pronouncement of the Permanent Court of International Justice, defining the regional powers of the European Commission of the Danube.

THE THEORY OF POZZOLANAS.

Building Research Bulletin No. 2, just issued by the Department of Scientific and Industrial Research is devoted to the character and classification of Pozzolanas, which play so important a part in the chemical and physical structure of cement. A substance is said to be pozzolanic when, while not necessarily cementitious by itself, it possesses constituents which will combine with hydrated lime at ordinary temperatures to form stable insoluble compounds of cementitious value. This action is of considerable importance in relation to the behaviour of mortars, cements and concretes in practice.

Pozzolanas are seldom used in England and their value for many classes of work is little appreciated. This bulletin describes the origin and properties of the principal natural and artificial pozzolanic materials, and has been compiled with the express object of providing information for the use of architects, technical workers and the trade.

The field covered includes their relation to Portland cement, types available and the general sources of natural, artificial and dual type pozzolanas.

THE PORT OF ASTORIA.

The Port of Astoria, Oregon, latitude 46 degrees 11 minutes north, longitude 123 degrees 51 minutes west, is located 14 miles from the entrance to the Columbia River, 108 miles by Willamette and Columbia Rivers from Portland, 640 miles north of San Francisco and 306 miles from Seattle by steamer routes. The Port District includes all of Clatsop County, in the extreme north-western corner of the State, and on the Columbia River extends from the mouth of the river to Westport, about 400 miles. The north bank of the lower river is included in the Astoria Customs District and the shipping is tributary to Astoria.

The recorded history of the Lower Columbia River and Astoria begins with the discovery and naming of the Columbia River by Captain Robert Gray on May 11th, 1792. The Lewis and Clark expedition was the first exploring party to reach the mouth of the river by the overland route, arriving on November 18th, 1805, and spending the winter of 1805-1806 near the present site of Astoria. In 1811 the Pacific Fur Company made the first attempt at permanent settlement and named their trading post Astoria in honour of John Jacob Astor, principal stockholder of the Company. They had expected to establish a chain of trading posts throughout the territory, but the War of 1812 and consequent lack of government aid and support forced abandonment of the enterprise and the post was taken over by their British rivals, the North-West Fur Company and re-named Fort George.

By the treaty following the war, the entire north-west country was made subject to joint occupancy by England and the United States. The number of American permanent settlers increased so rapidly and the demand for a stable government became so insistent that in 1846 the long dispute over ownership was finally settled by fixing the 49th parallel as the boundary between the two countries.

The Lower Columbia River area shared in the development which followed the establishment of American sovereignty. The fishing industry was one of the first to exploit the immense

natural resources of the region, commercial packing being started in 1866. This is still one of the big industries of the State, employing several thousand people and producing a pack valued at about one-and-a-quarter millions sterling per annum. Logging and lumbering started on a small scale at an early date and have grown very rapidly in recent years as the United States has become more dependent on the Pacific North-West for its lumber supply and as new foreign markets opened. Lumber and its products now form the basic cargo from the north-west. The commodities of local origin, together with wheat from the Inland Empire and flour ground from that wheat, first attracted commercial shipping. The constantly-increasing and more varied production, together with entrance and channel improvement, have been followed by a corresponding growth in shipping from the days of small sailing ships through the period of tramp steamship chartering to the present time when fast liner services by large modern steam and motor vessels carry most of the cargo.

The Port of Astoria was organised in 1910, commenced construction of facilities in 1914 and completed its last major construction in 1922. The City of Astoria is of greater commercial importance than indicated by its population as it is the trading, shipping and commercial centre of the Lower Columbia River district. There are still great timber resources available for manufacturing the products of the forest, amounting to about ten billion feet of commercial timber.

The United States Government completed construction of the jetties at the mouth of the river in 1915. Since that time the action of the natural tidal and river current has gradually increased the entrance depth and width until there is now an entrance channel of 47 ft. depth for a width of 2,500 ft., and 40 to 46 ft. depth over a width of 6,500 ft. at mean low water.

The present project provides for a minimum channel depth of 30 ft. and width of 300 ft., at mean low tide between Portland and sea, but this depth and width are exceeded between Astoria and the sea. The harbour has an anchorage ground of about 12 square miles varying in depth from 24 to 70 ft. The harbour at Astoria is a freshwater one, free from ice and unaffected by river freshet conditions. The average tidal range at Astoria is 7 ft. 5 in. The tide takes about 6 hours to pass from the Columbia River entrance to the mouth of the Willamette River. The tidal range decreases proportionately until it is about 1½ ft. at the mouth of the Willamette River.

The Columbia River entrance and harbour at Astoria are well equipped with navigation aids comprising a complete system of lighted ranges, lighted and unlighted buoys. The Columbia River lightship is stationed on the main channel range for entering the Columbia River, about 5½ miles south and west of the south jetty. It has a red hull with "Columbia" on each side and two masts. The lights, shown from each masthead are fixed white, 50 ft. above water and visible for 15 miles. The fog signal is a steam whistle, blast 2 seconds, silent 18 seconds, and the submarine bell signals 5 strokes every 30 seconds. The radio station, W.W.B.Q., receives and transmits messages whilst the radio fog signal calls three dashes for 60 seconds, silent 30 seconds.

North Head Lighthouse, a white conical tower, is on the west point of North Head, on the north side of the river entrance, 194 ft. above the water and visible 23 miles. Near the light is a United States weather bureau storm warning display station, with telegraph and telephone connections with Astoria and equipped with international code signals for reporting vessels and receiving messages.

Desdemona Sands Lighthouse is located on a sandbar in the river, about 7 miles east from the entrance between the jetties. The light is fixed white, shown 48 ft. above water from a white house on pile structure.

The Port of Astoria Terminal is located at Smith's Point in the western part of the city at the confluence of Young's Bay and the Columbia River. The piers extend to the main ship channel allowing vessels to berth or sail at any time without the use of tow boats. A depth of 35 to 40 ft. is maintained at all loading berths.

The terminal was constructed and is operated by the Port Commission as a public property open to all carriers and shippers. There are no port charges against the vessel loading or discharging cargo. Charges are assessed against cargo, and a berthage charge is made for a vessel lying idle. Port charges are absorbed by the carriers on cargo moving on through rail-and-water rates and on many routes port charges are partly absorbed by the steamship lines. Switching service to or from the Port Terminal and the Port's Belt Railroad is included in the line haul and local switching charges of the rail lines.

Pier 1 is 1,363 ft. long by 650 ft. wide, has a transit shed of hollow tile 1,363 ft. by 92 ft. There is 1,725 ft. of berthing space and track capacity for 89 cars. The concrete bulk grain elevator has a capacity of one-and-a-quarter million bushels.

Pier 2 is 1,445 ft. long by 425 ft. wide. The open pier is used principally for handling lumber shipments and bulky commodities in open storage. There is 3,178 ft. of berthing space and track capacity for 100 cars. The pier is equipped with three locomotive cranes of 20, 35 and 50 tons capacity. Pipe lines run from the pier to the storage plants of several oil companies.

Pier 3 is 1,750 ft. long by 550 ft. wide. There is a concrete transit shed 1,550 ft. long by 160 ft. wide. Berthing space amounts to 3,875 ft. and there is track capacity for 100 cars. Four electric travelling cranes operating on the roof of the transit shed and modern cargo handling equipment ensure fast handling of goods. A vacuum fumigating plant, complying with the requirements of the U.S. Horticultural Board is located in the warehouse. The type of construction and automatic sprinkler system permits low insurance rates on goods stored in this warehouse.

There are thirty-two privately-owned piers and wharves on the Astoria water front, mostly used for the private business of the owners. The principal private owned general cargo docks are the Callender Dock, 200 ft. by 50 ft.; Elmore Dock, 350 ft. by 300 ft.; Sanborn Dock, 1,000 ft. by 100 ft., and the Union Pacific Dock, 960 ft. by 60 ft. In addition there are a number of sawmill docks located on deep water and with facilities for accommodating large vessels.

A NOTABLE RESIGNATION.

We understand that Sir Westcott Abell, K.B.E., has resigned the office of Chief Ship Surveyor to Lloyd's Register of Shipping and is starting in business for himself as a Consultant.

Sir Westcott has had a distinguished career, having occupied several important positions. Educated at the Royal Naval Engineering College, Keyham, and the Royal Naval College, Greenwich, he became in due course a member of the Royal Corps of Naval Constructors. Afterwards he was successively appointed as Professional Secretary to the Director of Naval Construction, Instructor in Naval Architecture in the University of Liverpool. While at Liverpool he was appointed a member of the Board of Trade Committee on Load Line, becoming Chairman of the Technical Committee of that body, which dealt primarily with the relation of scantlings to the freeboard question.

In 1914, he was appointed Chief Ship Surveyor to Lloyd's Register of Shipping, and in that capacity was responsible for the preparation of the Revised Rules for the construction and classification of steel ships, which have given general satisfaction. The completion of that formidable task, for which Sir Westcott's work on the Load Line Committee eminently fitted him, leaves him now free to relinquish his official duties and to devote himself to private practice in which his many friends will wish him all success.

During the War Sir Westcott rendered valuable services to the country as a member of the Merchant Shipbuilding Advisory Committee and of the Admiralty Shipbuilding Council, and also as Technical Adviser to the Controller of Shipping. For these services Sir Westcott was granted the honour of K.B.E. in 1920.

CANADIAN FARMERS VISIT LIVERPOOL.

On January 17th, a party of 70 Canadian farmers, on a visit to this country, spent the day inspecting the Mersey Dock Estate. A visit was made to the new Gladstone Docks, at the northern extremity of the Liverpool Dock Estate, which will accommodate the largest ships afloat or likely to be launched for many years to come. Their attention was drawn to the exceptional cargo-handling facilities provided at the port and to the treble-storey quay sheds with road and rail access, and they were surprised to learn that even at the flood level of the River Mersey at the lowest neap tides there will be a depth of 42 ft. of water in these docks.

The gigantic River Entrance Lock also attracted their attention. This lock is 1,070 ft. long by 130 ft. wide. By means of it vessels can be docked at almost any state of the tide, this despite the fact that there is a tidal range on the Lancashire coast which sometimes exceeds 30 ft.

The party then proceeded to the Stanley Dock Tobacco Warehouse (the largest warehouse in the world), in which can be stored 70,000 hogsheads, seven-tenths of the tobacco storage accommodation at the port; and afterwards to the Corn Exchange, where they were received by the President of the Corn Trade Association.

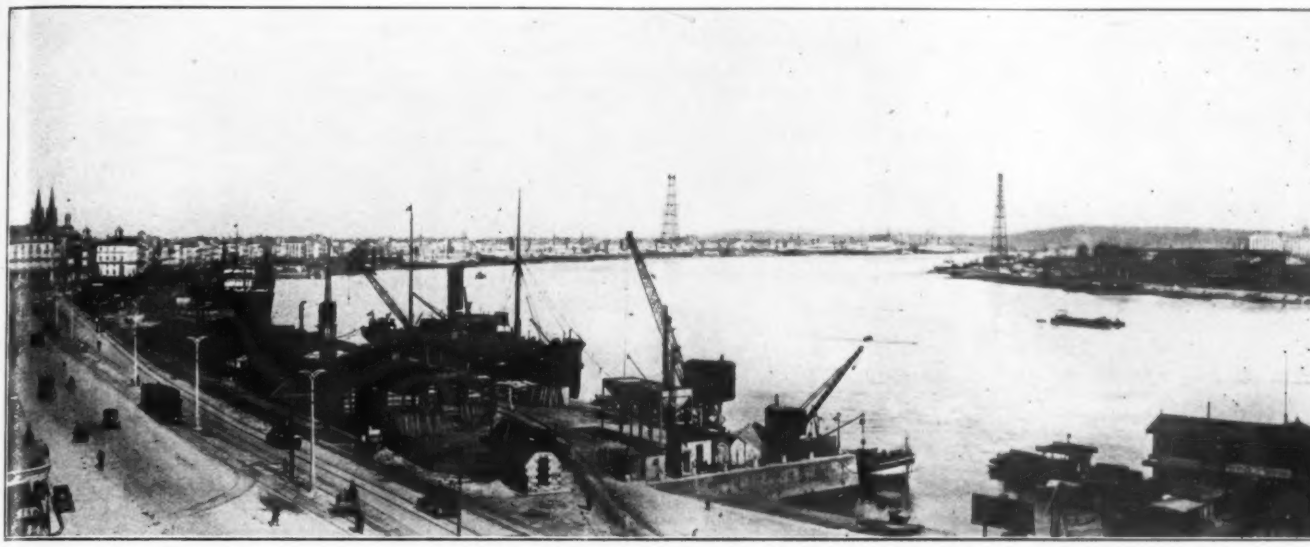
In the afternoon the farmers inspected the Mersey Cattle Wharf, the great landing place for livestock, which has been provided by the Mersey Docks and Harbour Board on their Birkenhead Dock Estate. This is the largest landing place for livestock in the world, having accommodation for 6,800 cattle and 22,000 sheep, and is situate on the river front behind the Woodside and Wallasey Landing Stages, at which the animals are landed at all states of the tide. All animals permitted to be landed at the present time have to be detained in the wharf under the supervision of Government Inspectors before being released for immediate slaughter or removal inland, and the slaughterhouse accommodation at the wharf is for 3,400 head of cattle and 3,000 sheep per day, while extensive chill rooms, having a capacity of 3,380 carcases, are in constant use.

The wharf is connected with the general railway systems of the country through the Birkenhead Dock Lines, both live animals and carcases being removed by rail as well as by road.

On their return from Birkenhead the farmers attended a reception by the Lord Mayor of Liverpool at the Town Hall. A dinner in their honour was held at the Adelphi Hotel later in the evening.

The Self-Managing Port of Bordeaux.

Improvements in Equipment during 1927.



Panorafnic View of the Port of Bordeaux.

TOPOGRAPHY.

A NATURAL market of one of the richest French parts, Bordeaux harbour owes its prosperity to unquestionable natural advantages, which are completed by the radiation of three great railroads (State—Southern and Paris—Orleans) which connect it with Paris—Lyons, the centre of France, Switzerland and the centre of Europe.

Being the nearest port from the great French Colonial Empire of Western Africa, it is moreover the direct market between France and Latin-America.

Its roadstead is absolutely safe, the tide, which in it keeps the same amplitude as at the Gironde's mouth, makes it accessible to most of the great modern ships.

But under exceptional circumstances, ships with a draught of about 26.5 ft. can enter without any difficulty.

Some years ago Bordeaux owed its fortune almost entirely to its wines traffic, as well as to its exotic products, but nowadays its activity is increased by the industrial development of its hinterland.

Its traffic in coal importation, which ranks it the second amongst the French coaling ports, is developing itself, thanks to its rich return freight, consisting of the exportation of pitprops from the Landes forest to the South Wales coalfields.

The improvement of the hydro-electric power resources of the valleys of the Pyrenees and of the Massif Central, actually in full activity, will bring it a new element of prosperity.

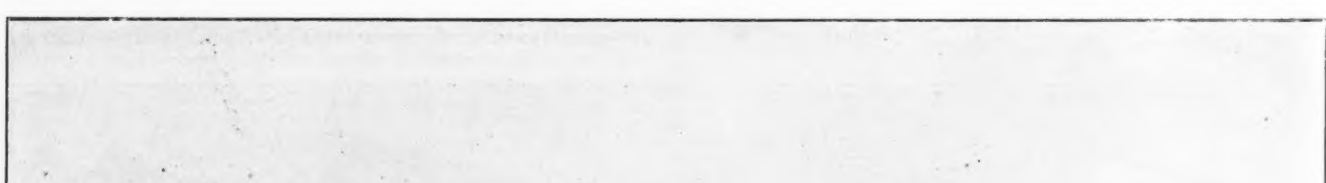
CONSTITUTION.

Assuming, on the 1st of January, 1925, the management of this important maritime establishment, the "Board of Administration," of the self-managing Port of Bordeaux, composed mostly of representatives of the local commercial

The 25,000-ton Floating Dock, constructed at the Vulcan Werks, Hamburg, under the Dawes Reparations Plan, on arrival at Bordeaux.

The Port of Bordeaux.

The completed Transit Shed H, at Les Gares Maritimes, Bordeaux.



View of 5-ton Electric Cranes handling Pit Props at the Port of Bordeaux.

interests, endeavoured to develop the installation and equipments of the harbour, in order to keep them in tune with its future prospects, yet taking into account its actual financial situation.

Wishing, first of all, to increase the already great handling facilities of its equipment, there was conceived a plan for its entire electrification.

Already, at "Queyries Wharves," specially designed for coal handling, ore and other heavy products, all the cranes have been entirely renewed. Thirty-three electric gantry-cranes, constructed in Jeumont's manufacturing works, will soon replace the old hydraulic cranes of the "Left Bank Wharves" assigned to the regular lines of passengers and cargoes.

Such a renewal of the equipment of these wharves, will complete the one-storey high warehouses for passengers and two for goods which were completed and opened during the year 1927; the two following, under construction, will be ready in a few months. Each warehouse is 492 ft. long, and 98 ft. wide on the ground floor and 78 ft. on the storey.

Bordeaux Self-managing Harbour found means of realising such a design, thanks to the application of reparations in kind due from Germany according to the Dawes Plan.

Three large gantry-cranes with a radius of 330 ft. and two luffing-cranes with a capacity of 15 tons and 30 tons, have thus been ordered in Germany.

NEW FLOATING DOCK.

A 25,000 ton floating-dock, built in Vulcan's Works in Hamburg, was delivered during last summer. This dock is entirely electrically controlled, its principal measurements being:—

Length	721 ft.
Moulded-breadth	138 ft.
Breadth	111 ft.

It is fitted with an electric central station composed of four generating sets with a power of 200 K.W.A. constructed by Messrs. Siemens-Schuckert. The four cycle six-cylinder Diesel engines are worked with gas-oil.

On the bridge of each side-box, runs a gantry-crane with movable jib, with a capacity of 5 tons for the greatest radius (65 ft.).

Berthed in the Gironde, at Pauillac, the dock was inaugurated on the 26th of September, 1927.

Furthermore, the Self-managing Port, has undertaken the repair of the Bassens Wharves, substituting for the wooden wharves during the war, quays in masonry with a piling foundation.

[The works are being vigorously prosecuted and are thought to be accelerated by means of reparations in kind. Such is the case in the execution of the Verdun pier, at the mouth of the Gironde, the pile driving essay of which took place in 1926. The open-air cross-cutting process, adapted to the local conditions by the engineers of the Self-managing Port, has proved fully satisfactory].

Shipping Movements in 1927.

Baltic and International Maritime Conference reviews the Position.

In a recently issued review of shipping movements during the past year, the Baltic and International Maritime Conference says:—

The shipping industry entered the year which has now elapsed under reminiscences of the great Coal Strike which had come to an end in December, 1926. This huge tug-of-war between employers and employees which, in fact, was more than a fight for wages and labour conditions than any other struggle of this kind, made its influence heavily felt on the world's trade in general and on shipping in particular.

The balance sheets of the shipping companies issued in the early part of the year show that the talk of a boom in shipping during and after the Coal Strike was nothing but a myth, as, apart from exceptions, the nominally higher freights which were paid in certain trades during that period to a greater extent had been consumed by other factors coupled with the same origin as the higher freights.

The freight market during 1927 has proved different to the various categories of tramp ships, and, generally speaking, owners of the larger tonnage have been able to carry on their trade, if not on a very lucrative basis, in most cases with both ends meeting, whilst the owners of the smaller sized ships have found themselves face to face with circumstances on nearly all markets where this tonnage is employed which must necessarily show a deficit when they are making up their accounts for the past year.

The typical curve in most markets shows a fall in the beginning of the year, followed by a certain improvement which culminated in July, since when the curve has been on a downward bent. The greatest disappointment of the year is the Baltic Market, which is the backbone of the smaller tonnage. While rates during the opening and middle of the season were maintained on a basis yielding a balance or smaller profit, the most extraordinary phenomenon has occurred that October and the time onwards, the closing of the season, which is not only the busy season but also the season bringing with it the reduction in the carrying capacity of the ships, has shown a total collapse. The rates were on an average 4s. less with winter deck-loads than they were in the midst of the season, when the ships could carry their full cargoes. Coal is a commodity which plays a prominent part in the business of shipowners, and although it must be admitted that the cost of coals to be consumed on board the ships has been brought down to prices which nearly compare with pre-war level, the depression in the coal trade is nevertheless seriously reflecting itself upon shipping owing to the scarcity of coal cargoes to be carried and the exceedingly low freights which are ruling. In fact, coal cargoes to nearly all destinations are carried at less than the actual cost of carrying on the transport, and coal cargoes are therefore more or less looked upon as a means of bringing the ships into position for other cargoes.

The calculation on the part of shipowners is therefore a very close one when the owner is faced with the alternative whether it is more expensive to sail in ballast or to take the coal cargo. The danger of the position here is a double one because, first of all, ships are not intended to sail empty; and, secondly, the idea of sending ships in ballast greatly tends to spoil any market where an upward tendency, ever so small and ever so temporary, is likely to benefit shipping in general.

The cost of running the business is still too high, not only in regard to the actual cost of wages and maintenance, but, in particular, as far as the cost of visiting ports and the handling of cargoes are concerned.

The trading public in nearly all countries is more or less harassed by excessive taxation, mainly due to ever increasing experiments in social reforms and public support of individuals, national trade, and, in instances, even the shipping industry of certain countries. In most countries the state and municipalities are draining the commercial resources of their own inhabitants, unaware of the fact that they kill the hen which lays the golden eggs.

Over-taxation, as far as shipping is concerned, is more unjustified than in the case of any other industry, because shipping does not in any case draw upon the national exchequer except in countries where shipping is carried on on the unnatural basis of a State subsidy. Shipping, in a direct way, pays for all services rendered by the official or semi-official corporations.

Further, we are sorry it must be recorded that shipping is still, in many cases, taxed in countries other than where the owner is domiciled, although the international collaboration to avoid this form of quackery has made some progress during the year.

The past year has thus, as has been the case with its five or six predecessors, caused the owners considerable anxiety. The question of organised regulation of tonnage after having been in the background for some time has again revived, and is still being studied seriously by committees of experts. In the meantime, the seriousness of the situation has forced upon individual owners the necessity of taking their tonnage to the dolphins.

The total amount of tonnage laid up in Great Britain in October was not less than 272,839 nett registered tons. For Germany no statistics are available, as very likely comparatively few ships are laid up in that country. In Belgium seven ships of 21,200 tons d.w., and in Holland four ships of 22,600 d.w. were lying idle by the turn of the year.

In Scandinavia the position is very serious, and in Norway not less than 99 ships of 203,540 tons d.w. were laid up on the 31st December. The corresponding figures for Sweden are 28 steamers and 44,700 tons d.w., and for Denmark 27 steamers of 42,500 tons d.w. New vessels are being taken out of service every day as soon as they can be directed to their home waters, and it is beyond doubt that the Scandinavian tonnage laid up in the coming winter months will be considerable.

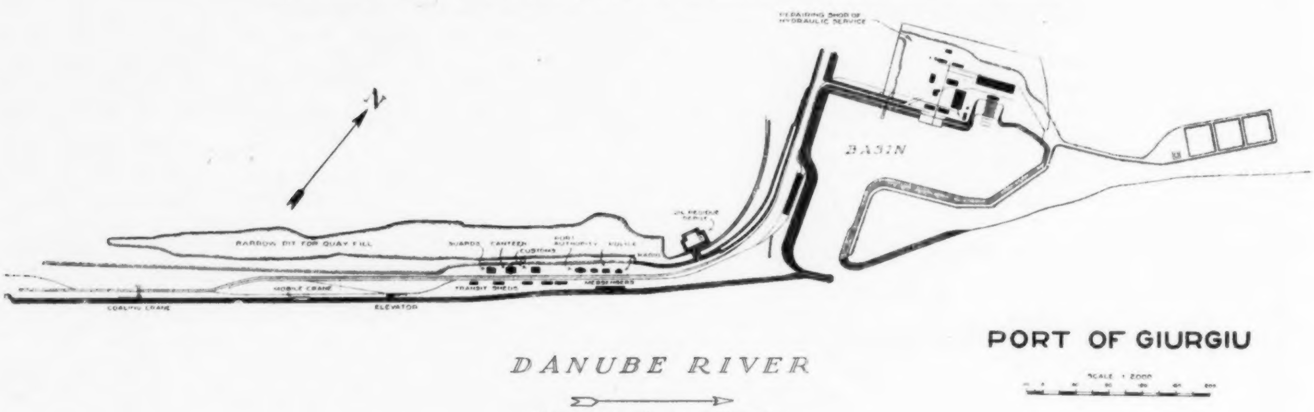
However much the situation is to be regretted, we hope that these ships, which are all of the smaller sized type, will have a stimulating influence on the markets from which they have been withdrawn. The trouble is, however, the lack of system as far as laying up is concerned, as we have in previous years seen that one steamer is laid up simultaneously with another boat of the same size and type being put into service again after having been idle.

If some method could be found to organise the laying up, preferably coupled with a scheme of economic co-operation and indemnity for those owners who lay up their vessels, the position would certainly be improved. There is, however, one thing to which owners already now should give their serious consideration, and that is whether it is not good policy to lay up their ships rather than enter into any charter that does not give some reasonable hope of a margin of profit. Pending a judgment of the supply of tonnage to the world's requirements, either by natural process or by an organised and scientific scheme, if this should be found possible, it is only an aggravation and perpetuation of the present distress to accept, even as a temporary expedient, rates that involve loss.

The Ports of Rumania.*

I.—Danube Navigation and the Port of Giurgiu.

By ROY S. MAC ELWEE, Commissioner of Port Development, Charleston, South Carolina, B.S., M.A., Ph.D. Maps and Drawings by HENRY F. CHURCH, Assistant Commissioner Bureau of Port Development, Charleston, South Carolina.



Map of the Port of Giurgiu.

GEOGRAPHICAL LOCATION AND AUTHORITIES.

DUE to its favourable location the Kingdom of Rumania is of great importance in the transportation system of Europe. The great inland waterway of Central and Eastern Europe, the Danube, meets the sea within its boundaries. The Rumanian Government, fully aware of its trust and its own opportunity, has put forward great effort to develop Danube navigation and its sea ports.

The Kingdom of Rumania holds a similar position in Europe to that of the State of Louisiana in North America that embraces the delta of the Mississippi. Within its boundaries is the delta of the great Danube waterway with 2,900 kilometres (1,810 miles) of inland navigation, reaching from Ulm in Würtemberg to the Black Sea, the second largest river system in Europe after the Volga, but through a much more populous territory. The trans-shipping points between river and ocean navigation, the twin ports of Braila (170 kilometres—106 miles—from Sulina) and Galatz (150 kilometres—94 miles—from Sulina) occupy a similar position to that of the Port of New Orleans.

The jurisdiction of Rumania covers the following stretches of river navigation (upon one or both banks):—

Of importance also is Constanza on the Black Sea, and Giurgiu, the purely river port on the Danube, serving Bucharest.

Principal Danube Waterways.

	Km.
Sulina to Galatz (for ocean vessels to 24 ft.)	156
Galatz to Varciorova (for barges 3 metres, 10 ft.)	794
Varciorova to Bazias	125
	1075

Secondary Waterways: Branches of the Danube.

	Km.
Chilia	90
St. Georges	75
Macin	100
Borcea	110
Ostrov (Deruent)	20
	395

Rivers and Canals other than the Danube.

	Km.
Pruth (Ungheni to mouth)	410
Dniester (Hotin to Cetatea Alba)	740
Mures (frontier to Pisky)	185
Canal of Bega (frontier to Temisoara)	35
	1370

Total ... 2840 km.

Of these watercourses both banks are in Rumanian territory for a distance of 1,485 kilometres. This makes a total of 4,325 kilometres of river bank under Rumanian jurisdiction, and requiring supervision and maintenance.

FAVOURABLE GEOGRAPHY.

The economic and political importance of the Ports of Galatz and Braila situated at the head of ocean navigation of the Danube, at the Ocean-River transfer point on the longest river of Europe, except the Volga, is apparent at once. The Danube navigation ties together all of Southern and South-Eastern Europe on one great water highway. The characteristics of the traffic of the Danube, manufactured products down stream, and cereals up-stream gives a two-way haul for the Danube barges. The Danube forms a prolongation of the ancient route from the Indies through the Levant to Europe. The logical route for merchandise coming from East of Suez or out of the Caspian and Black Sea regions would be by way of the Danube to Central Europe rather than the long voyage to a North European port for trans-shipment to the Rhine, Elbe, or Oder inland waterway system into South Germany and Czechoslovakia.

The failure of the full exploitation of the Danube on the basis of its geographical worth is due to the personal element in commerce and the fact that commerce tends through the ages to form its own river bed, its own *Talweg*, by means of its own currents. During several centuries, the mouth of the Danube has been the battle zone for contending Turks and Tartars. The small bordering states of the Lower Danube have only enjoyed a national existence in recent times, since the Peace of Paris, 1856, concluding the Crimean War. For centuries they have been the scene of war and counter-wars, oppression and revolt to such an extent that commerce on the Danube was not permitted to develop. Even to-day the petty jealousies of the extremely nationalistic Danubian States, with frequent fishing-in-troubled-waters by the greater powers, do not permit the full utilisation of this splendid waterway. During these early centuries of disorder, the Asiatic, Levant, Lombardian, Portuguese, and British merchants, the merchants and ship operators of the Hanseatic League and finally the various Western European maritime nations built up their avenues of commerce and markets, avoiding the logical but unsafe Danube waterway. To cut into this commerce now established by centuries, will require a long period of co-operation of all the Danubian States. It will require the representation of the old commercial houses of Western Europe by branches at the trans-shipping ports at the mouth of the Danube in order to gradually divert traffic from the round-about but well-established northern routes, that logically should go by way of the Danube.

The example is not isolated; the gulf ports and ports of the South Atlantic have suffered a similar fate in the past, and are successfully overcoming similar handicaps of commercial inertia.

RUMANIAN PORTS SERVE A LARGE HINTERLAND.

Rail connections from Braila and Galatz permit these ports to serve the regions of Bessarabia, Moldavia, Bucovina, Wallachia, also Transylvania. The Southern part of Poland is easily accessible to the ports of Braila and Galatz. These form a logical outlet for the Silesian-Galician coal and the importation of cotton for the mills of Lodz and the exports to the Near East of the products of the Lodz cotton mills.

Czechoslovakia manufactures many articles exported in large quantities to the Near East and also to the Far East, the best route being by way of the Danube with trans-shipment to ocean vessels at its mouth, in place of the Elbe-Oder waterway to Western and Northern Europe. Also, Czechoslovakia is a great consuming country to feed its dense manufacturing population. This would supply a return cargo of grain for the barge line operation on the Danube in this trade.

* En route to and from Cairo, Egypt, as an official delegate of the United States to the XIVth International Navigation Congress, the author had opportunity to thoroughly inspect a number of well-known and less-known ports under most favourable auspices. The results will appear in these pages from time to time.—Editor.

The installation of free trade zones permitting manufacturing at these ports will give American and English capital a splendid opportunity to manufacture materials for distribution in the Near and Far East. A special opportunity is presented for the manufacture of all kinds of machinery for the petroleum industry such as pipe, drilling rigs, etc. The plant manufacturing pipe for pipe lines and oil wells would avoid the import taxes, freight costs, and also take advantage of low native wages. It should be easy to compete with the high prices made necessary by long transportation costs and high production costs of competing imported oil well and pipe line equipment.

To further extend the hinterland of the Ports of Galatz and Braila, a canal is projected between the Vistula and the Danube by way of the San and the Pruth.

The Rumanian seaports in general, Constanza, Braila, and Galatz, given continued stability of government and the ensuing stimulus to commercial enterprises, not only in Rumania, but throughout the valley of the Danube, may view with satisfaction the prosperous future that comes from performing an economic function of basic value.

THE FREE PORT MOVEMENT IN RUMANIA.

A glance at the map of Europe showing the physical location of Rumania will indicate the advantage to the Rumanian ports of an introduction of a system of foreign trade zones, called free ports. In the United States, out of deference to Congressman Fordney's feelings, to whom anything with the word " free " in it was anathema, the United States has been using the words " Foreign Trade Zone," to indicate the Hamburg, Bremen, and Copenhagen systems of free ports. By free ports is meant a waterfront area separated from the consuming customs area by a fence and no customs supervision exercised until it is desired to move the merchandise through the fence for consumption or use. Within the zone one may operate free from customs supervision and interference.

It will be noted that either on the waters of the Danube or overland by rail, the ports of the lower Danube, Braila, and Galatz, are peculiarly well-adapted to a trans-shipment trade. The " Polish Corridor " and Danzig on the north form only a precarious outlet for Poland, often obstructed for long periods by ice in the winter time, and political uncertainty all of the time. The entire southern part of Poland, including Galicia, is easily accessible by rail through Braila and Galatz. Cars may be loaded in a free port, sealed and forwarded in bond. Likewise the northern boundary of Bulgaria, served by the Danube, is readily accessible to merchandise by river barges, trans-shipment in bond at the meeting of the barge and the ocean ship at Galatz and Braila. The same applies to Jugo-Slavia. In fact, Hungary could profit by trans-shipment via Danube barge communication from such a free port.

It is not surprising that such brilliant and far-seeing statesmen as Vintila Bratianu, Minister of Finance, and brother of the late Premier Ion I. C. Bratianu; General Valleanu, former Minister of Communication; and Mr. Garoflid, former Minister of Agriculture; Director-General Vardela, and others are actively studying the possibility of the establishment of free trade zones, Rumania has the beginning already at hand at Braila.

The establishment of a free trade zone is merely a matter of pen and ink, authorising customs officials to retire to a customs fence located back from the wharves. There is no great cost involved, except for the high stout fence and some striped guard post houses at the gateways of the fence.

THE RUMANIAN GOVERNMENT ORGANISATION FOR PORTS AND WATERWAYS.

The present government organisation for the development of ports and waterways in Rumania was created under the law of March 15th, 1908. This law established a bureau in the Department of Public Works known as the Bureau of Ports and Waterways (Direction Générale des Ports et des Voies de Communication par Eau), with headquarters in Bucharest. The Port Bureau is divided into seven divisions.

1. The Service for the Construction and Promotion of the Port of Constanza.
2. The Hydraulic Service (Hydrographic and Conservancy).
3. The Service of Maritime Navigation.
4. The Service of River Navigation.
5. The Shipyard at T. Severin.
6. The Service of Docks and Warehouses of Galatz and Braila.
7. The Inspectorate General of Ports and Navigation.

The public officers are: a Director-General, from the Corps of Inspectors General and of the Engineers' and Technical Corps of the State; an Assistant Director-General who also must be from among the Inspectors General of the Engineer and Technical Corps of the State; and the necessary administrative and technical personnel as limited by the budget. The appointment and re-call of the Director-General, the Assistant Director-General, and the Chiefs of Services and other functionaries come under the laws of the Civil Service established for the State railways by the law of the 19th of March, 1883. Prior to the present law the service as developed in its initial stages was under the Minister of Foreign Affairs. The law became effective April 1st, 1901, under King Carol I.

The present very able Minister of Communications is M. C. Dimitriu, who in the cabinet change of June 5th, 1927, succeeded General G. C. Valleanu. The Director-General is M. Jean Vardela, who succeeded an able engineer and first director, Prof. George Popesco. Both of these engineers received their technical training in Germany and France, and came well equipped to their profession.

M. VARDELA.
Director-General of the Rumanian Bureau of Ports and Waterways.

In discussing the question of centralised port control versus port autonomy, the arguments in favour of centralised control for Rumania are very sound, although they would not apply elsewhere except under similar conditions. Centralised control of all the ports and waterways in Rumania is necessary, first, because the various cities where port development is taking place are not in themselves of sufficient size and wealth to support the necessary technical talent, nor to raise the necessary funds to carry on this port development. Even if the funds were available, the number of trained port development engineers in Rumania, just as it is almost everywhere else in the world, is so small that the supply would not be sufficient to insure the best possible engineering and port development ability at each one of the ports. A system of centralised port control is justified in Rumania while in France the system of the autonomous port has been developing rapidly. However, Rumania has no port cities the size of Havre or Bordeaux or Marseilles, and competitive port building among Rumanian cities may be disastrous, or at least result in a much unwarranted over-investment in facilities, or conversely no facilities might be forthcoming at all.

INTERNATIONAL CO-OPERATION IN DANUBE NAVIGATION.

The area now occupied by Rumania was settled by the legions of Emperor Trajan in about 100 A.D. The Roman influence from that date has survived in the roots of the Rumanian language, along with the very name Rumania itself, through the long centuries of exploitation by Turkish tax collectors and frequent Russian invasions. There have been many efforts by the Slavs to break through to the Mediterranean waters. The Peace of Paris, following the Crimean War, March 30th, 1856, marked the first united effort of the Danube States to assure concerted action in river navigation matters. Two Commissions resulted, the first, the European Danube Commission was created to improve the channel of the Sulina mouth of the Danube to Braila. The first chief engineer was Sir Charles Hartley. Work on the Sulina mouth was begun at that time. The International Danube Commission composed of representatives of all river bank states was also created by the same treaty with jurisdiction from Braila to Ulm. The Peace of Vienna, 1815, had already established free Danube navigation for vessels of all flags.

Russia was not satisfied with the reverses of the Crimean War and eventually another Russo-Turkish war was again ended in turning the Slavs back from the Dardanelles. The Treaty of Berlin, July 13th, 1878, re-established both commissions. The European Commission has had certain very definitely circumscribed duties and work to perform but the International Commission has had a wider and larger field.

The Treaty of Versailles following the World War, in which the Slavs and the Turks locked horns again, for control of the Dardanelles, continued the two commissions, but it has introduced some changes in the International Commission that may or may not work out in practice. The old International Commission was composed of representatives of river bank nations; Articles 346-347 of the Treaty of Versailles admits representatives of abutting states (except Baden) formerly included and "provisionally" (but without time limit) any other states whose sea interests in the Danube are sufficiently serious and when admitted by a unanimous vote of the Commission. This admitted England, France and Italy, not border states. The question of admitting outside members creates the possibility of packing the Commission and of playing outside, and to the Danube irrevelant politics would seem to be a bad policy. A return to the old International Danube Commission of 1878 would seem preferable.

Also, the words "International" and "Internationalised" have become thick and obscure at Versailles. The reasons are obvious, an effort to internationalise politically and gain a political control over the great waterways, the Rhine and Danube. The Treaties of Berlin, 1878, and Paris, 1856, aimed at economic freedom of these waterways, the free use by vessels of all flags, but no idea of attempting to infringe upon the sovereign powers whose territory extended to the bed of the stream, or across the bed of the whole stream, by any fancied transfer of the universal law of freedom of the High Seas, admitted extra-territorial waters since the days of Grotius. That such an idea is actually not working is seen in the refusal of ratification of a recent decision of the commission on the part of Rumania. The Commission never has been, and Versailles has not made the International Commission of the "internationalised" waterway sovereign, politically over abutting states. Now, as heretofore, the navigation of the Danube is free to all nationalities, where all questions of mutual interest of the border, abutting, or river bank states are discussed in the Commission and the resulting rules and regulations become law within the waters of each state after ratification by that state. The earliest return to a strictly abutting state commission will be advisable.

The headquarters of the International Danube Commission is at Pressbourg (since 1921). The headquarters of the European Danube Commission is at Galatz.

PRE-WAR DANUBE NAVIGATION FLOURISHED.

Some idea of the extent of the commerce of the Danube before 1914 may be gained from the size of the chief companies then operating.

The Austrian Navigation Company (La Société Navigation Autrichienne, known as the D.D.S.G.), was the oldest company operating on the Danube, taking advantage of the liberties accorded by the Treaty of Paris of 1856. During the days of the Austrian-Hungarian Empire, the Empire made up the losses by a subvention. Before the War, this company possessed 134 tow-boats with a total of 58,365 indicated horse power, 851 river barges with a total capacity of 442,249 metric tons. It also possessed 45 passenger boats representing a total of 19,920 indicated horse power. The total value of its fleet at that time was 90 millions of gold francs ($18,000,000). It operated on regular schedules between Regensurg and Sulina. The total annual revenue was approximately 21,500,000 gold francs ($4,300,000). The profit was 3,500,000 francs ($700,000) and the imperial subvention was 1,200,000 Austrian crowns ($259,000) a year (1 *krone* equalled 21 cents.).

The second navigation company was the Société Hongroise de Navigation, known as the M.P.T.R. This company founded in 1895 had 14 passenger vessels, 48 tow-boats and 262 barges, of 5,650 h.p., 18,900 h.p., and 139,196 tons capacity respectively.

The third company, The South German Company, Société Sud-Allemande, possessed before the War 11 tow-boats of 6,000 h.p. and 99 barges of 63,773 tons. This company had no subvention.

There were several other companies; Société Serbe, S.R.D.; Société Roumaine Danubienne; Société Russe, etc.

Before the World War the movement of tonnage on the Danube was divided as follows: Bavaria, 433,000 tons; Bulgaria, 669,000; Austria, 2,590,000; Hungary, 5,094,000; Rumania, 5,837,000 metric tons (1 metric ton equally 2,204 lbs.)

RUMANIAN AND DANUBE NAVIGATION SINCE THE WORLD WAR.

The effect of the War on this enormous movement of river navigation was disastrous. Two hundred and fifty Danube vessels, with an aggregate tonnage capacity of 150,000 metric tons, were sunk. The only navigation companies which have been able to function after the War are the N.F.R., Navigation Fluviale Roumaine; the S.R.D., Société Roumaine Danubienne, in Rumanian, Serviciul Roman Dunavian; the S.M.R. Serviciul Maritim Roman; the Lloyd-Triestin; the S.S.N. La Société Serbe de Navigation; and also the Inter-Allied Danube Commission has exploited a certain number of barges and tow-boats in commercial service on the waterway; the C.E.D. Compagnie Européen de Danube.

The burden of the rehabilitation of Danubian commerce has fallen most heavily upon Rumania as Rumania has the greatest mileage of channel and greatest stake in this commerce. Not only is the river commerce itself of all the many small Rumanian ports involved, but the larger portion of the commerce of the ports of Braila and Galatz.

The office of the River Navigation of Rumania, La Navigation Fluviale Roumaine (N.F.R.), is a Government bureau in the Ministry of Communication. The bureau engages in the business of transporting both passengers and merchandise upon the Danube, the Pruth and the Tisa. The N.F.R. operates nineteen passenger steamers of different tonnages according to the importance of the lines of traffic. The passenger lines are as follows:—

1. Galatz-Braila.
2. Galatz-Turnu-Severin.
3. Galatz-Silistra.

1. Braila-Tulcea-Sulina.
2. Braila-Tulcea-Ismail-Valcov.
4. Braila-Macin.

1. Calarasi-Silistra-Ostrov, Giurgiu-Rusciuc (across the river from Giurgiu in Bulgaria), T. Severin-Bazias, Calafat-Vidin.

During the year 1925, 722,388 passengers and 4,324,096 kilos of baggage (4,324 metric tons) were transported by these lines.

The passenger landing stages are of the floating barge and bridge type at the various ports. The steamers themselves are delightful and correspond to the well-known type of Rhine passenger steamers. There are no steamers of the size of the Hudson River Night or Day Lines between New York and Albany. Nevertheless, these steamers are large and comfortable, also very prettily furnished and decorated, and the food is excellent. Due to the higher rates on the railroads made necessary by the fall in the value of the *lei* and the resulting very high prices in buying railroad equipment and supplies outside of Rumania, the passenger steamers have been exceptionally popular during the past few years, as they afforded substantial savings in fares.

The freight service of the N.F.R. consists of a fleet of 25 tow-boats with a total of 12,260 i.h.p., and 150 barges, varying in capacity from 400 to 1,500 metric tons (2,204 lbs.). The fleet has a total dead weight capacity of 95,280 metric tons. There is also a fleet of twelve tank barges for petroleum products varying from 350 to 800 tons capacity with a total capacity of 5,100 metric tons.

This river freight service of the N.F.R. carries both package freight and bulk freight. The tank barges carry various petroleum products, both crude and refined.

The N.F.R. service operates regularly freight lines on definite schedules and also carries merchandise on charter. The regular freight lines, largely for package freight, are as follows:

From Galatz-Turnu-Severin and return 3 times a month.
From Braila-Sulina and return 2 times a month.
From Turnu-Severin-Bazias and return twice a week.
From Braila-Valcov and return once a week.
From Calarasi-Silistra and return daily.
From Giurgiu-Rusciuc and return daily.
From Galatz-Braila and return daily.
From Braila-Macin and return daily.
From Calafat-Vidin and return daily.

The chartered services, those not operating upon fixed schedules, but as business offers, carry merchandise from Giurgiu to Turnu-Severin, and Orsova as far as Belgrade, Novisad, Bratislava, and petroleum products from Giurgiu even to Budapest and Vienna.

During the year 1925 the regular barge lines carried 31,247.6 metric tons of merchandise, and the chartered services carried in towed barges and tank barges 171,257 metric tons of cargo.

The charges for the liner services, both freight and passenger, are on the basis of a filed fixed tariff. The tramp or charter services are determined according to supply and demand in each case. There is plenty of competition on the charter services of the Upper Danube. Although the N.F.R. is a government institution with government regulations as far as staff and employees are concerned, its operations are conducted on a strictly transportation business basis in competition with other nationally and privately-owned barge lines.

The total Danube fleet (1) under the Rumanian flag publicly owned, and (2) under the Rumanian flag, privately owned, and (3) under foreign flags, but calling at Rumanian ports are given in the following table:—

The ocean-going government and privately-owned Rumanian flag vessels are also attached although these operate largely out of Constanza.

The Rumanian Merchant Marine in 1925.

1.—RIVER FLEET (DANUBE).

(a) Under the Rumanian Flag, Government Owned.

17 passenger vessels (N.F.R.) with a total indicated steam h.p.	6,900
23 tow boats (N.F.R.) with a total indicated steam h.p. ...	12,000
229 barges, tank barges and canal boats—	
Of these, 147 barges, 12 tank barges, operated by the N.F.R., 2 lighters, with a total carrying capacity of (m. tons) ...	140,728
Including 68 barges owned by the Ministry of Communications and chartered to private individuals .... (m. tons)	45,000
Total carrying capacity .... (m. tons)	185,728

(b) Under Rumanian Flag, privately owned.

4 passenger vessels with a total indicated steam h.p. of	1,655
79 tow boats with a total indicated steam h.p. of	11,423
456 barges and tank barges—	
Of these, 340 river barges (called schlops or chalands, ca. 1,000 tons), 22 tank barges, 94 canal boats (péniches ca. 300 to 400 tons), total carrying capacity of (metric tons)	333,676
Total metric capacity of (metric tons)	333,676

(c) Under Foreign Flags calling at Rumanian Ports.

63 tow boats with a total indicated steam h.p. of	15,022
263 river barges with a capacity of .... (m. tons)	241,895

2.—OCEAN FLEET.

5 passenger steamers, Government owned, displacement (m. tons)	22,000
8 cargo boats, owned by the Government, total displacement (m. tons)	55,000
10 cargo boats, privately owned, total displacement (m. tons)	56,000
2 tankers .... (m. tons)	25,000

RUMANIAN OPERATIONS TO IMPROVE DANUBE NAVIGATION, ACCORDING TO BUDGETS FOR 1925 AND 1926.

The Budgets for the years 1925 and 1926 will serve as an example to give a picture of the extent of the work involved in repairing the ravages of the World War on the Danube. The Budget figures are given in *lei*, normally equivalent to the French franc, in 1926, about 200 to the dollar or ½ cent. But this foreign exchange value is far below the value in exchange for labour and materials within the country. The real value of this Budget would be hard to fix, yet the amounts within the boundaries of the country are large sums to raise.

The removal and, where possible, salvaging of sunken tow-boats and barges has been a heavy work. The sunken barges, by diverting the current, have changed the river bed and made dredging, sounding, re-making, re-buoying and other conservancy labours expensive and difficult. Yet this work is absolutely essential to maintain a minimum channel of 3 metres at mean low water throughout the length of the river. The Budget item for sounding to locate shoals was 1,240,000 lei; re-lighting and re-buoying from kilometre 940 to kilometre 170 was 2,650,000 lei, which includes 15 light buoys, 67 simple buoys and 11 spar buoys. The item of 9,870,000 lei is devoted to the removal of obstructions to navigation. This consisted in salvaging sunken barges 3, 10, 18, pontoon 17, the removal of the wreck of barge 6, of pontoon 5, salvaging of two barges and the tow-boat *Ileana*. The item for dredging was 15,200,000 lei. The item for re-placing the kilometre markers that had deteriorated or disappeared, these being replaced in reinforced concrete, was 1,100,000 lei. The very valuable work of the daily hydrographic map showing the stages of the water throughout the length of the navigable Danube in Rumanian waters amounts to 580,000 lei for the year. The preparation of a new map for the use of navigators of the Danube amounts to 650,000 lei. In other words, Director-General Vardela's Budget for 1925 on the Rumanian Danube alone amounted to 31,290,000 lei.

The total amount of dredging amounts to about 1,000,000 to 1,500,000 cubic metres a year (1 cu. m. equals 1.1 cu. yds.).

The Budget for 1926 totalled 35,300,000 lei, covering approximately the same items as in 1925.

It might be mentioned that there are still a great many sunken craft and other obstacles in the channel, and that only a certain amount of work can be carried on each year. This work has been going forward since the restoration of peace and will probably continue for some time to come before all obstructions have been removed.

There is one complication in the salvaging of Danube barges; the question of original ownership. According to international law on the high seas the abandoned wreck is the property of the salvager. The wrecks in the Danube are considered, quite correctly, as abandoned property and a menace to navigation.

This brief summary will serve to indicate something of the problems concerning the Rumanian Government in its efforts to restore to pre-war condition of the navigation of the Danube. Although the burden of this rehabilitation is falling upon Rumania also the greatest reward of this labour is the development of its own ports of Giurgiu, Braila, and Galatz.

THE RIVER PORT OF GIURGIU ON THE DANUBE.

The Port of Giurgiu, the principal Danubian port of Rumania and the trans-shipment point of river traffic to Bucharest, is situated between kilometres 491 and 494. The port is connected with Bucharest by a broad, level and fairly good highway and a railroad. The traffic of the Port of Giurgiu in 1925 and 1926 totalled 320,681 and 415,442 tons respectively, details of which are as follows:—

Traffic of the Port of Giurgiu in 1926.

Entered:

	Metric tons.
General Merchandise	129,296
Grain	2,449
Total ...	131,745

Cleared:

	Metric tons.
General Merchandise	71,248
Grain	58,795
Gasoline (benzine)	108,559
Kerosene	9,525
Motorine	27,108
Lubricating oils	9,158
Crude oil	93,110
Refined oils	37,939
Total ...	415,442

Traffic in 1925.

Entered:

	Metric tons.
General Merchandise	111,438
Grain	611
Total ...	112,049

Cleared:

	Metric tons.
General Merchandise	43,935
Grain	56,744
Benzine (gasoline)	81,040
Mineral oils	12,484
Lubricating oils	29,527
Kerosene	73,374
Crude oil	18,870
Refined oils	4,706
Total ...	320,680

THE PORT LAY-OUT.

The port consists of the four Rumanian ports' characteristic elements of (1) a long river bank and (2) an excavated basin. Mr. Georges Popesco, the first Director, in his years of study, came to the conviction that paved inclined revetments on the river bank, a two-to-one slope, or three-to-one, was far superior to any attempt to construct quay walls, due to the fact that the scour of the current had the tendency to undermine the vertical wall and cause its failure.

The connections between ship and shore are by means of landing stages along the river, barges anchored off shore with connecting bridges. During the two months of ice during the winter from about Christmas time to the end of February, these landing barges are towed into the basin and the bridges are hauled ashore.

The long river quay is made-land to an elevation well above maximum high water. This has left a moat noted on the map as the Groapa de Imprumut. This is fairly well grown up with forest and young growth, and is of no particular significance. It will be noted that the quays are equipped with transit sheds, warehouse, travelling cranes, and railroad track connections. The administrative buildings, waiting rooms, ticket offices, etc., are housed in a very attractive white stone building in simple but characteristic Rumanian architecture, resembling Romanesque. This excellent construction is conspicuous at all the four ports inspected and, doubtless, at many others.

The principal goods transfer of the port takes place along the river bank.

The inner port basin is a typical artificial dredged basin, or "tidal" dock. It will be noted from the map that the entrance inclines down stream and is protected by a short jetty at an angle of about 30 degrees from the shore line. The banks of the basin are also paved revetments on a slope of 2½ or 3 to one. The strip of land dividing the river from the basin approximately at kilometres 492, is now being developed as a petroleum products station. Only recently a fire occurred at this station, but it is being rebuilt on a larger and more efficient scale.

The principal activity of the Port of Giurgiu in addition to the transhipment of goods to Bucharest and neighbouring territory, is the ship building and repair plant with shops maintained by the Government, and located on the inner basin. Much machinery, one fine large machine shop, and also a concrete wharf were constructed by the Germans during the World War. To judge by the substantial character of this construction, Mackensen's men were settling down to stay. Here the Rumanian Government builds its own tow-boats and barges, especially its dredges and its salvaging apparatus. The activity of this station during the last decade has been confined almost entirely to repairs and salvage. It was mentioned above that the Danube fleet was sunk to the extent of approximately 250 tow-boats and barges. These barges are obstructions to navigation as well as frequently of salvage value.

The salvaging method is worthy of consideration. The method has been to construct a catamaran lifting equipment by connecting two barges by two bridges of equal length with footing amidship of the two river barges. It was found necessary from experience to have the footing of the bridges amidship in each catamaran and the weight thoroughly distributed throughout the length and breadth of the barges to distribute

the lifting forces in the full. These bridges are then equipped with heavy duty winding machinery and pumps. The largest catamaran salvaging barge has a lifting capacity of 400 tons.

The preliminary work on the barge to be salvaged consists first in passing the chain under the barge. The barge has been sunk for several years and is, therefore, completely drifted full of sand. A powerful jet of water from the pumps wash out the sand sufficiently in a channel under each barge, fore and aft. Divers pass a steel cable under the vessel and then by means of the cable draw the lifting chains through and make fast to the bridge lifting mechanism on each side.

The hull is frequently completely filled with sand. It is therefore necessary to wash the sand out of the hull by means of power water jets from the pumps, or suck it out with a suction dredge. More frequently ordinary suction dredge with a flexible intake drag removes the greater portion of the sand. The barge having been secured and having been lightened, is then raised and carried into the Giurgiu basin for dry docking and repair if not too far gone, or for breaking up. The salvaging fleet of the Giurgiu work consists of three large catamarans, of several heavy duty cranes and a number of tow-boats.

The chief engineer of the Port of Giurgiu received his engineering education in England.

Giurgiu can be cited as an excellent example of a river port of both river bank and interior basin variety. It possesses every facility for the transfer of goods from railroad to barge, barge to railroad or to truck. Over 415,000 metric tons of traffic in 1926 is a fair sized port, similar to 297,000 short tons for the U.S. Warrier River Service, or 444,000 short tons of local tonnage for the U.S. Mississippi service (total all traffic including transhipped freight, 1,044,650 short tons).

As a matter of comparison with American sea, lake, or river ports a few are listed:

1926.	Long tons (2,240-lbs.)
Giurgiu	415,000
Ashtabula, Ohio	456,391
Providence, R.I.	459,459
Chicago, Ill.	401,118
Duluth, Minn.	353,905
Freeport, Texas	349,664
Texas City, Texas	327,677
Erie, Pa.	322,028

(*To be continued*).

Strange Uses of Sea Water.

By E. T. ELLIS.

Sea water has many strange and interesting applications of one kind or another. It seems to me to be a great pity, having studied it closely, that more use is not made of it. Other countries are far ahead of us in this direction, and are making big profits out of a liquid of which there is, for all intents and purposes, an unlimited supply.

Let us take a few ways in which sea water can be turned to advantage, and if these are carefully examined many other strange uses for it are likely to come to light. Its complicated composition need not deter even the most unskilled experimenter, as in the majority of cases the sea-salt, otherwise sodium chloride, is the predominant chemical present in solution.

I have long been expecting some of the more progressive coast towns to start manufacturing baking soda from their sea water, as such an industry is long overdue on our shores. The preparation of baking soda is a somewhat technical matter, but I will endeavour to explain how it is done, using sea-water as the starting point.

The first step, as a rule, consists of treating the sea-water in machines known as multiple evaporators, until so much water is evaporated from it that the common salt begins to crystallise out. This is purified in various ways, and is again dissolved in a small quantity of pure water. A strong solution of this is next treated with waste ammonia gas from manufacturing operations, and is subsequently further treated with another waste gas, namely carbon dioxide, which is the major constituent of ordinary chimney smoke. Baking soda is deposited on the floor and sides of the vessels, and after running off the remaining liquid, it is washed with a very small quantity of pure water, and further purified, if necessary, in other ways.

HYDROCHLORIC ACID.

Another almost equally strange use of sea-water is its employment in the manufacture of hydrochloric acid, otherwise known as spirits of salt. Enormous quantities of this acid are consumed in the chemical industry every year, but up to now, as far as I know, only a fraction of this quantity is actually prepared from sea-water.

The first step in the right direction is again to treat the sea-water in multiple evaporators, so as to obtain as large an amount of sea-salt from it as can be secured. The sea-salt, however, instead of being re-dissolved in pure water, is next treated with strong sulphuric acid. Hydrochloric acid is immediately released even in the cold, although it is usual to heat the acid and salt together in retorts. The acid is given off in the form of dense whitish clouds of gas, and must be led into cylinders containing pure water, in which it is rapidly dissolved. It can be purified and decolourised, if necessary, both easily and cheaply. The residue that remains in the retorts is mostly sodium sulphate or acid sodium sulphate, and has many important technical applications.

LEAD CHLORIDE.

The employment of sea-water as a precipitating agent is by no means a new idea, although it is practised to a very limited extent in this country at the present time. The manufacture of lead chloride, however, of which large quantities are required, and of which even larger amounts are likely to be demanded in the near future, is certainly to be commended in view of the ease with which it can be carried out.

In some instances where a specially pure chloride is required it is deemed desirable to evaporate in the already mentioned manner until the salt crystallises, and to purify this before operating with it. In most instances, however, sea-water itself can be used directly as the precipitating agent, it being run after filtering, into vats containing a soluble lead salt, such as sugar of lead, or lead nitrate. Lead chloride is not very soluble in water as most readers will already know, and the chloride of the salt water changes place with the nitrate or acetate of the lead, depositing lead chloride in the form of a fine powder on the floor, sides, etc., of the vats. After the chloride has thoroughly settled the liquid can be run off, and the precipitate is then thoroughly washed, dried and ground.

SEA-WATER IN SOAP WORKS.

Another strange use of sea-water is its employment in soap works, and as far as I know this is practised only to a very limited extent in this country.

Every traveller is aware that ordinary common soap does not dissolve readily in sea-water, but that the special marine soaps are pretty satisfactory. Surely, therefore, advantage of this fact should be taken by soap manufacturers for the separation of the soap from their other liquors instead of going to the trouble and expense of buying fresh salt for the purpose as they do at the present time.

In most instances to employ sea-water for soap precipitation it is desirable to treat the liquid in multiple evaporators until at any rate a large portion of the water is evaporated off. Some claim that it is best to evaporate until the salt is actually obtained, and purify this by re-crystallisation prior to re-dissolving it in fresh water so that a brine of any desired strength can be obtained. If this is done a purer soap is obviously produced. For the crude kind, however, concentrated sea water itself is quite good enough as a precipitating agent.

SILVER CHLORIDE.

Another instance of the employment of sea-water as a precipitating agent is in the preparation of silver chloride. This chemical is required in large quantities, and its price would be lower than it is to-day if a cheaper precipitating agent was used.

The process is broadly the same as that already described when speaking of lead chloride. The best starting silver solution is one of silver nitrate, and although ordinary untreated sea-water can quite well be used, better results are obtained by treating it in evaporators until its volume is so reduced that a nearly saturated solution is obtained. On mixing the silver nitrate with the salt water double decomposition promptly takes place, silver chloride being deposited as a precipitate, and sodium nitrate, otherwise saltpetre, remaining dissolved.

The solution and precipitate are then easily separated by passing them through large mechanically operated filters, after which the chloride is carefully washed several times, slowly dried, and then finely ground.

FURTHER POSSIBILITIES.

There is a host of other possible uses of sea-water. Thus it might be largely used in the manufacture of caustic soda, in the production of chloride and chloride of lime, the preparation of doctor's drugs of various kinds, while it is already employed to some extent in obtaining drinking water, to a less extent in the manufacture of fuel, and might well be utilised in the preparation of glauber salts. Hydrogen for heating can be obtained from it, as well as sodium hypochlorite for disinfecting, while table salt and washing soda are almost as easily produced.

SHIPPING TRAFFIC AT LUBECK IN 1927.

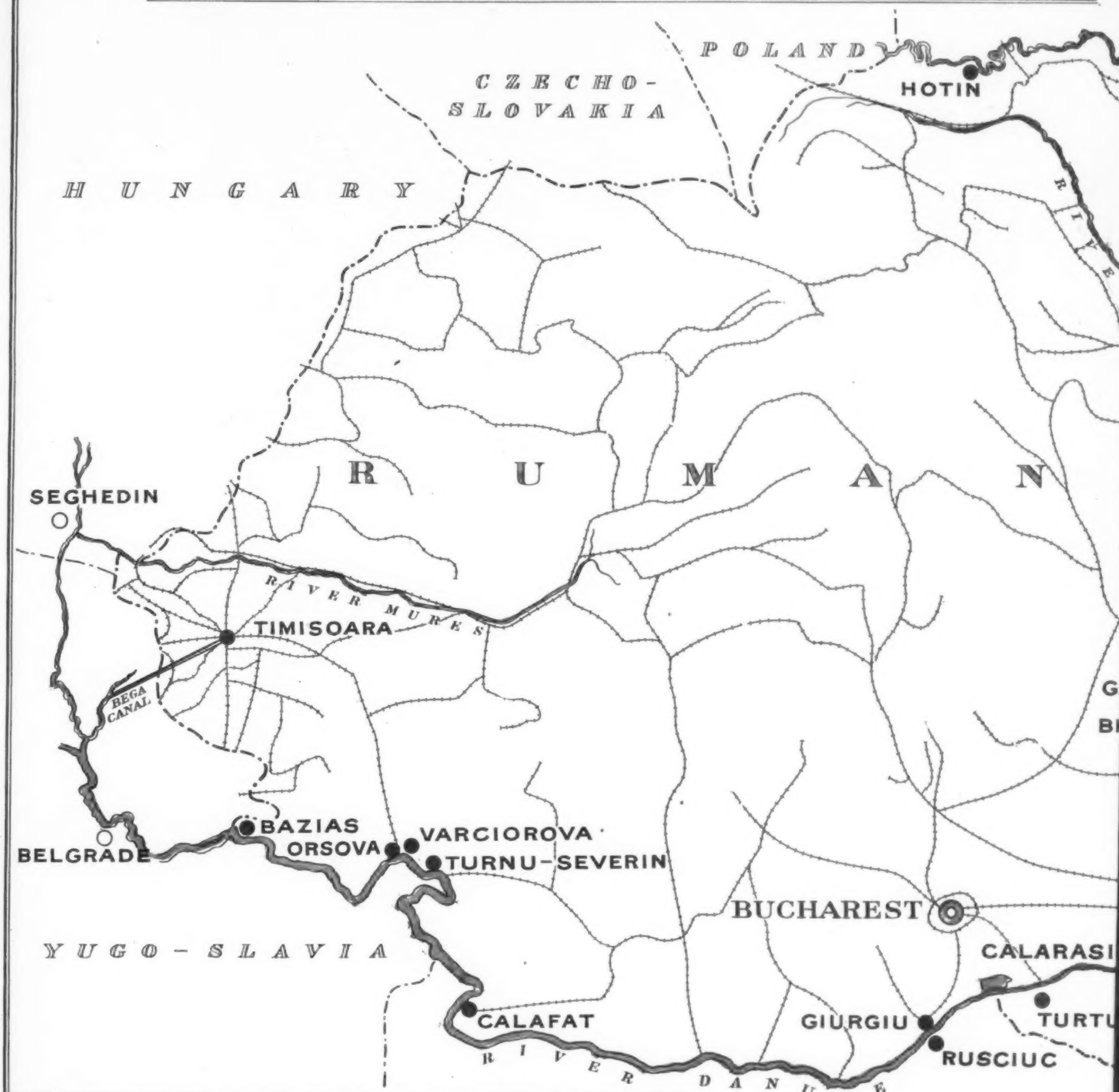
During the year 1927, 4,458 (1926: 4,212) vessels aggregating 933,231 (838,159) net registered tons entered the Port of Lübeck and 4,424 (4,197) vessels aggregating 933,434 (838,048) net registered tons cleared.

The goods traffic showed a total movement of 1,732,324 tons as against 1,463,192 tons in 1926, including re-exports, 553,254 (663,791).

Although the pre-war figures have not yet been reached the year's working shows considerable increase on 1926. The figures represent 93 per cent. tonnage and 87 per cent. goods traffic of the 1913 figures.

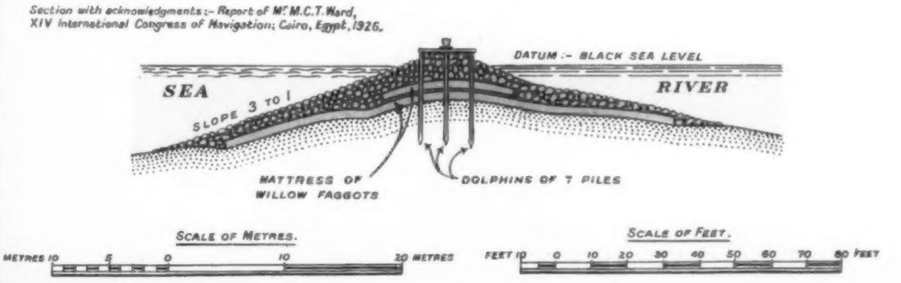
THE PORTS OF RUMANIA.

UNDER THE ADMINISTRATION OF THE BUREAU OF PORTS & WATERWAYS, DEPARTMENT OF PUBLIC WORKS, BUCHAREST.



SECTION OF JETTIES — SULINA MOUTH OF THE DANUBE.

Section with acknowledgments:– Report of Mr. M.C.T. Ward, XIV International Congress of Navigation; Cairo, Egypt, 1926.



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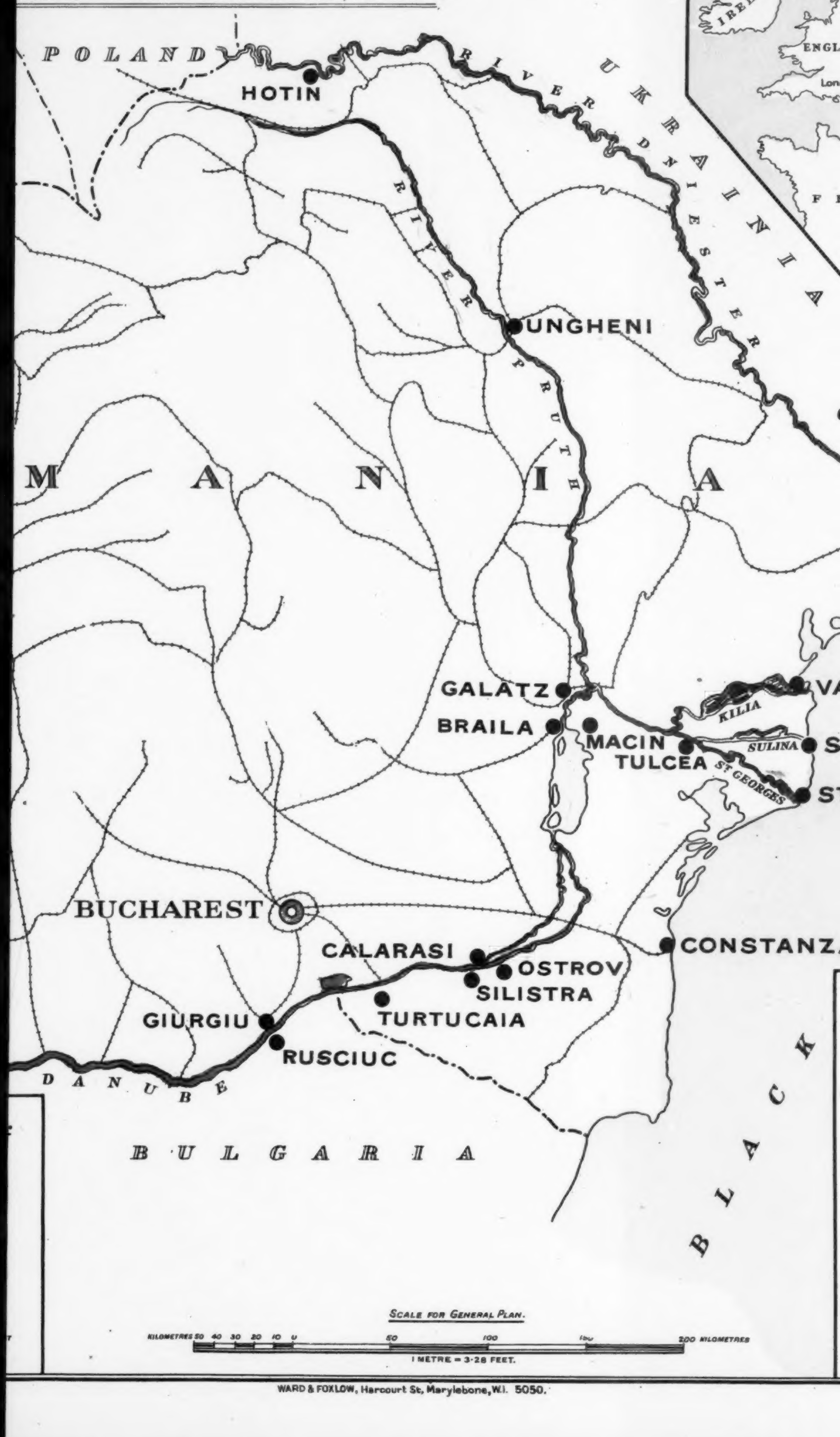


WARD & FOXLOW, Harcourt St, Marylebone, W.1. 5050.

TY – FEBRUARY, 1928.

Modern Portland Cement Plant.*

Including a Survey of Raw Materials and Processes.

By HAL GUTTERIDGE, A.M.I.Mech.E., M.I.E.I., Consulting Engineer.

BEFORE considering in detail the individual units of a modern cement plant, a brief survey of the processes that take place during the manufacture of Portland cement may be made.

RAW MATERIALS.

In the manufacture of Portland cement, a variety of raw materials is used, which may be classed under two general heads, (1) calcareous and (2) argillaceous. In the former lime predominates, and in the latter silica and alumina are in the greater proportion. The following list divides the raw materials into these categories:—

Calcareous.	Argillaceous.
Limestone.	Clay.
Marl.	Shale.
Chalk.	Slate.
Marine Shells.	Blast furnace slag.

Cement rock, which is extensively used in America as a raw material and in many cases as the sole raw material, may be classed either as calcareous or argillaceous. In some deposits, such as those at Nazareth, Philadelphia, cement rock contains so high a proportion of lime that it is necessary to mix some slate or clay with it, while in the Lehigh District, where the rock contains less than 75 per cent. of carbonate of lime, it is necessary to add a sufficient quantity of purer limestone to bring up the mixture to that percentage.

Fig. 1. Caterpillar Tractor and Scrapers.

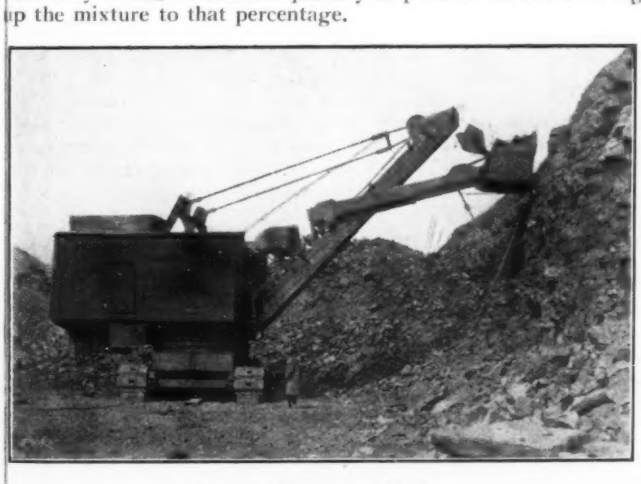


Fig. 2. Mechanical Navvy.

On the Thames and Medway,* Portland cement is made from local chalk and estuary mud or clay, which are frequently found in close proximity, and are mixed roughly in the proportion of three of white chalk to one of clay, or four of grey chalk to one of clay. In the Burnham district, beds of gault clay crop out; this is combined with grey chalk and made into Portland cement. In Warwickshire and South Wales the blue lias formation, which contains both limestone and shale in alternate layers, is found. In the neighbourhood of Hull hard chalk and clay are used; and in Bedfordshire and Cambridgeshire soft chalk, marl and clay are the raw materials.

THE MANUFACTURE OF PORTLAND CEMENT.

The materials pass through three departments, (a) preparation of the raw materials, (b) burning, and (c) grinding.

There are two processes by which Portland cement is manufactured. These are known respectively as the "wet" or "thick slurry" process and the "dry" process. They differ only in the treatment of the raw materials. All the plants in this country, except three or four, are operating on the wet process; but in America, many Portland cement plants use the dry process.

WET PROCESS.

In the wet process, the raw materials are treated in slightly different ways, mainly depending on their physical properties. When limestone and clay are used, the limestone coming from the quarry is crushed dry, and if necessary the clay is put through rollers or breakers. They are then fed, in proper proportions and with the addition of water, to one or more reducing mills of selected type, where they are ground to a slurry of the consistence of thick cream containing from 34 to 45 per cent. of water. Alternatively, the clay may be reduced to a slurry in a wash-mill and added to the limestone slurry during or after grinding.

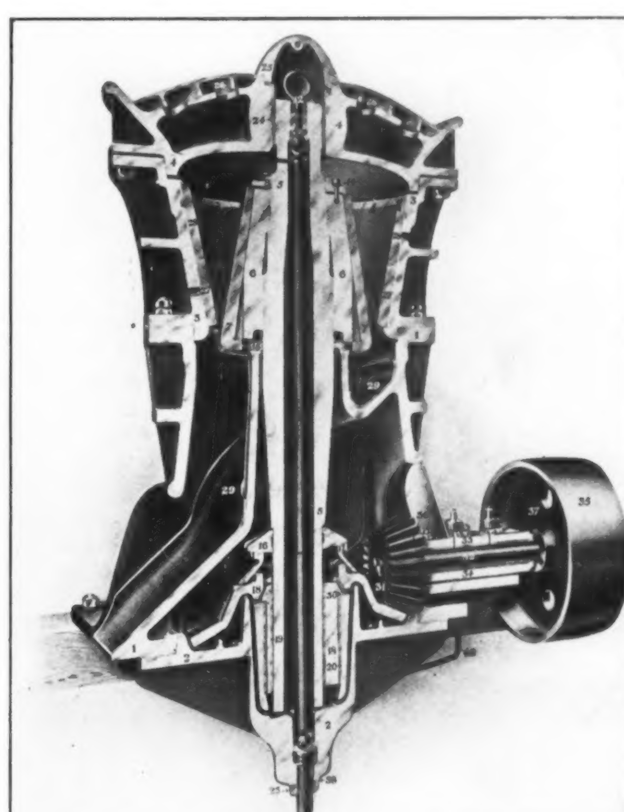


Fig. 3. "Gyratory" Crusher.

* "Portland Cement," by D. B. Butler.
* Reproduced by courtesy of the Institution of Mechanical Engineers.

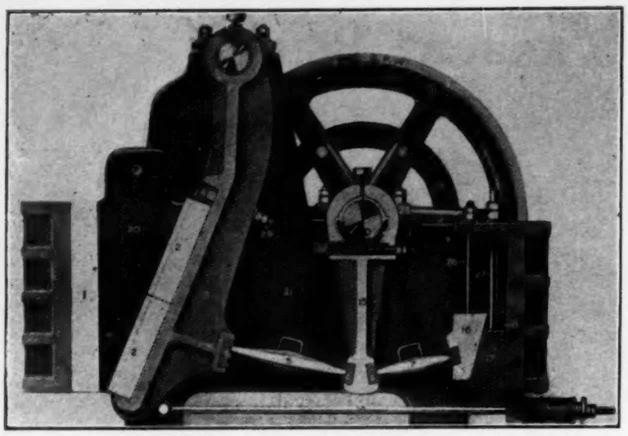


Fig. 4. Toggle-Joint Jaw Crusher.

In the case of soft chalk and clay, each of these materials is put direct into a wash-mill with the correct amount of water, passed through sieves to reject coarse particles, ground together in a mill if necessary, again mixed, corrected, and then sent forward to the kilns for burning.

DRY PROCESS.

In the dry process, the raw materials as quarried are first crushed to pass a 1½-inch ring and smaller, and are then elevated to storage bins. As they are required, the materials are passed through the driers, generally of the rotary type, are ground together or separately in a dry state in one or more reducing mills, and finally, in the form of a very fine powder called "meal," are thoroughly mixed. The meal is moistened before being fed into the kiln.

BURNING PLANT—KILNS.

The type of kiln in universal use in modern practice is the rotary kiln, which, by its greater economy and ease of control has superseded the fixed continuous kiln. The raw materials, either in the form of slurry or "meal," are fed into the kiln at the higher end, travel slowly down the length of the kiln by means of its rotation and downward inclination, and emerge at the firing end in the form of clinker to fall by gravity into the "cooler."

COOLERS.

The cooler, usually tubular in form similar to the kiln, is generally set with a slight inclination to the horizontal and revolved slowly. It receives the hot clinker from the kiln and transfers a part of the heat in it to a current of air, which enters at the open end of the cooler and passes through it and into the kiln on its way to the chimney.

GRINDING, STORING AND PACKING PLANT.

The clinker from the cooler is conveyed to storage, and from there to the grinding mills. Before the clinker enters the grinding mills, gypsum is added to retard the setting time of the cement, the quantity being about 2 to 3 per cent. by weight of the clinker. Usually a single grinding unit only is employed, but in some plants a primary and a secondary grinder are arranged in series. The material discharged from the grinding mills is the finished article, "Portland cement." After leaving the grinding mills, the cement is conveyed to the cement silos and from these to the packing department.

GENERAL CONSIDERATIONS.

PROVING THE RAW MATERIALS.

It is unnecessary to stress the value of careful and thorough proving when prospecting for raw materials for the manufacture of Portland cement. The value of the raw materials must be ascertained by complete tests, both of quality and quantity, by taking regular representative samples over the whole of the property, the number of bore-holes and their depths depending

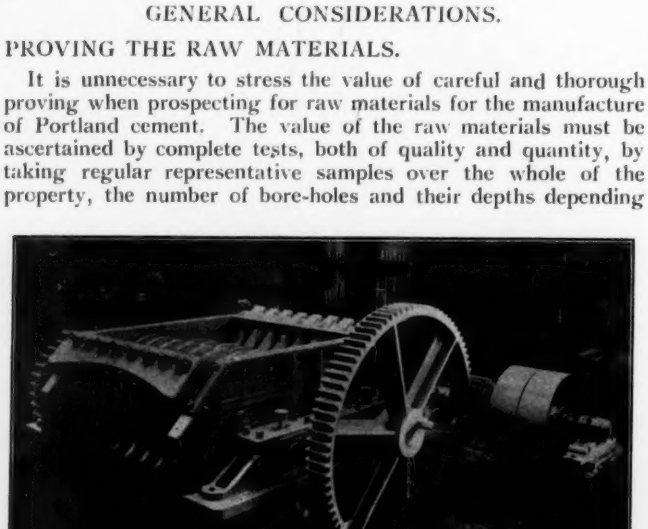


Fig. 5. Kibbing Rolls, 3ft. 6in. diameter, by 4ft. 5in.

Fig. 6. "Sun and Planet" Mixer.

on the variation of the materials. This information is also necessary for the chemist when the mill is in operation as he can then arrange the order in which the quarries shall be worked, so that the proportions of the final mixture can be obtained with the minimum amount of labour, waste, storage, and treatment. Upon the results of this investigation will also depend not only the design of the plant, but also to a great extent the position of the works.

After the analyses of the materials have been made, charts are generally drawn showing the quality at various depths over the whole area of the property. Representative samples are then burned in a laboratory kiln and cement made from them. Finally the chemical and physical tests are carried out, due allowance being made for the slightly different conditions obtaining in the laboratory from those in the commercial manufacture of cement, for instance, as regards the ash content from the fuel burnt.

THE LAY-OUT OF THE WORKS.

The results of the investigations of the raw materials proving satisfactory, the question of the site and lay-out of the works next arises. The ideal lay-out, if it could be so arranged, would be to have the quarries at one end of a straight line and each succeeding process of treatment following one after another with the packing operation as the last of the line. The fuel-treatment plant would be arranged on one side of the centre-line at or near the firing end of the kiln, and the gypsum plant on the other side near the clinker-grinding plant. This general lay-out permits an economical arrangement of railway tracks and wharves on both sides of the factory for the quick loading of the finished product and for the supplies of fuel and gypsum. If a site can be chosen where there is a fall of the ground from the quarries to the factory, every opportunity should be taken to handle the materials by gravitation throughout the departments, and thus to save capital and running costs.

FUEL FOR FIRING THE KILNS.

The fuels used for firing rotary kilns are pulverized coal, oil, and gas. Of these, the most frequently used is pulverized coal, mainly on account of its advantage in price; but gas in particular, and oil to a lesser extent, have the advantage that they mix with the air supplied for combustion much more readily than pulverized coal. Further, neither gas nor oil contaminates the clinker with ash to the same extent as coal does. In this country coal is invariably used, but in other countries all three fuels are employed.

The kind of coal generally used is what is known in this country as "small slacks" having a calorific value of about 12,000 B.Th.U.'s per lb.; the percentage of moisture and the ash content should be as low as possible. The quantity of coal required in a rotary kiln, in the wet process, varies from 26 to 33 per cent. of "standard" coal of 7,000 calories per kilogramme of the weight of clinker produced. To convert the weight of coal as received into tons of "standard" coal, the

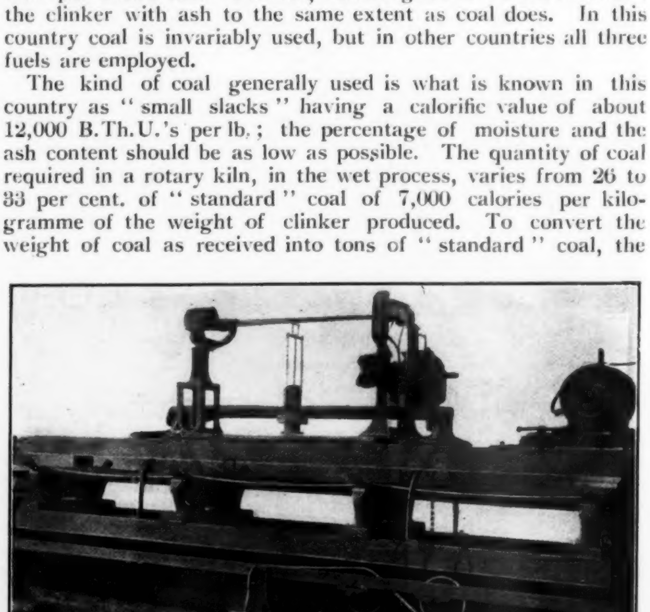


Fig. 7. Automatic Recording Continuous Conveyor.

procedure is as follows. If a coal as received gave a calorific value of 6,500 calories per kilogramme, and 6 per cent. of moisture, then one ton of it is equal to $\frac{6,500 \times 94}{7,000 \times 100} = 0.87$ ton of "standard" coal. If 18s. per ton was the price paid for the coal, its standard price value would be $18 \div 0.87 = 20$s. 8d. per ton.

Below are set out in the form of "flow sheets" typical treatments of the raw materials in the manufacture of cement by the wet and dry processes respectively:—

WET PROCESS (Hard Chalk and Clay).

CHALK QUARRY
Digger
Crusher
Rotary Screen
Rejects to Jaw Crusher
Wet Grinding Mill
———Chalk Mixer———

CLAY QUARRY
Digger
Rolls
Wash-mill
Slurry Mixer
Wet-Tube Mill
Finished Slurry Storage
Slurry Pump
Rotary Kiln

COAL PLANT
Crusher
Coal-Drier
Pulverizer
——————————Rotary Kiln
Cooler
———Gypsum
Clinker Grinding Mill
Cement Storage
Cement Packing.

DRY PROCESS (Limestone and Clay).

LIMESTONE QUARRY
Digger
Crushers
Storage
———Drier——

CLAY QUARRY
Digger
Breaker
Storage
———Drier———

Hoppers
Grinding Mill
Correcting Mixers
Storage
Fuel —————Kiln
Cooler
Clinker Storage
———Gypsum
Clinker Grinding Mill
Cement Storage.
Packing Machines

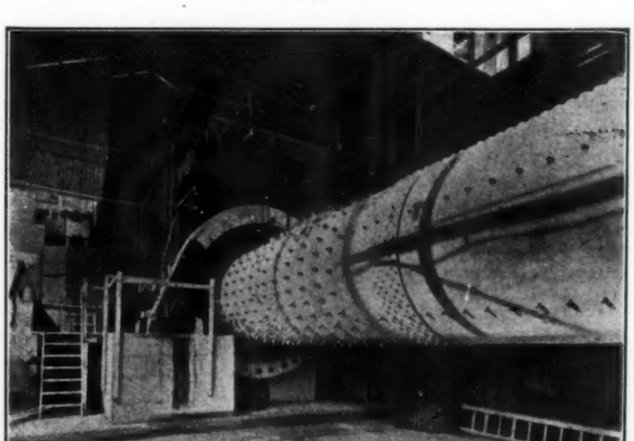


Fig. 8. "Combination" Mill.

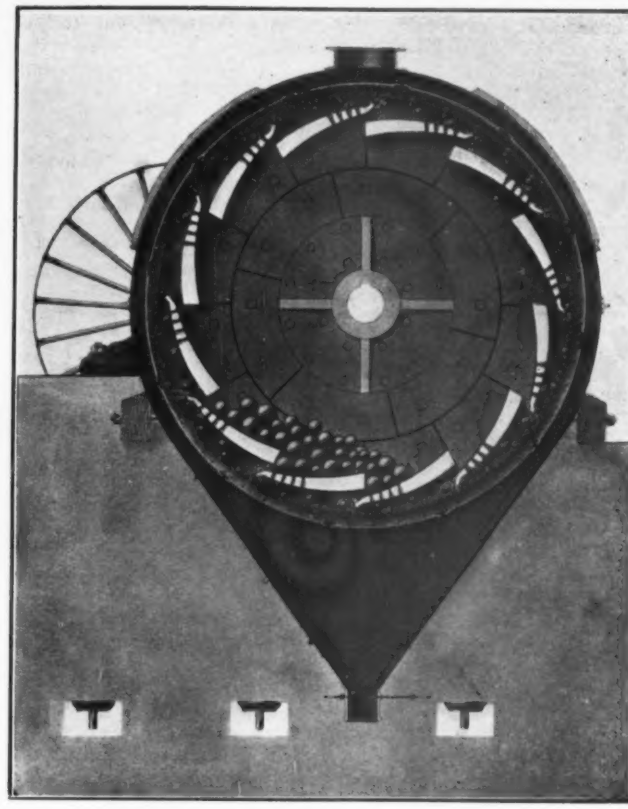


Fig. 9. Sectional View of Ball Mill.

SHRINKAGE.

When designing the raw material preparation plant, there must be taken into account what is known as "shrinkage," for there is a greater weight of raw materials passed through the preparation plant than is produced in the form of cement. The great loss occurs by the evaporation of the admixed water (in the wet process), and the extent of this depends on the percentage of moisture in the slurry. Further losses take place in driving off combined water, CO_2 and other gases, and dust. All of these pass out with the flue gases except a portion of the dust which is arrested in the dust-chamber and is returned to the slurry. The amount of dust so returned reduces the gross shrinkage. From the coal that is burned in the kiln, a certain amount of ash is deposited in the clinker, and the gross shrinkage is also reduced by that amount. The amount of actual shrinkage of the raw materials (excluding the water content) during their passage through the various processes depends on the raw materials used, but it is not unusual to find that it is necessary to provide $1\frac{3}{4}$ tons of solids for every ton of cement produced. When, as in the case of the wet process, the water content is included, the amount of slurry by weight that has to be pumped may be $2\frac{1}{2}$ tons per ton of cement produced.

QUARRYING: REMOVING OVERBURDEN.

In practically all deposits there is an overlay of soil which may be from 6 inches to 5 feet thick. In order to remove this overburden, suitable tools have to be provided, and in some cases mechanical diggers, which are ordinarily used for digging the raw materials, can be economically used for this work also. With a mill of a large output, however, it is often more economical to provide a tool for this purpose alone, as not only has the overburden to be dug, but it has also to be moved to a site whence it will not have to be removed. If a mechanical digger be employed on this work, it still is necessary to lay track and provide trucks and haulage locomotives to remove this waste material to the selected dump. An efficient tool which is in use in this country and which not only digs up the material, but conveys it to any dump and deposits it, without a second handling, is shown in Fig. 1. This tool consists of a petrol-motor mounted on caterpillar tracks and followed by a number of scrapers in train. The scraper scoops up a load at the appropriate spot, and when full are automatically lifted clear of the ground. They carry the material till the load is released on the dump by the attendant, after which they return to the site. The whole of this cycle is performed without stopping. With two men and three scrapers in train it is

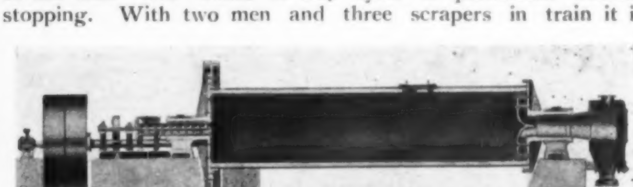


Fig. 10. Tube Mill in Section.

reported that 10,000 cubic yards were removed in 300 working hours, the haulage being 150 yards. The cost was less than 6d. per cubic yard, including labour, interest on capital, depreciation, and working costs.

EXCAVATING TOOLS.

For digging soft chalk, marl, clay, and similar soft materials, the most useful kind of tool is a mechanical navvy of the type shown in Fig. 2. This may be operated by steam, oil, or electricity, and is generally mounted on caterpillar tracks, and should be capable of revolving in a complete circle. The navvy digs the material and places it direct into the raw material trucks. When the raw materials are too hard to be dug directly, they are first blasted and then picked up by a digger or grab and jib-crane, and placed in the trucks. For very soft materials, such as clay or mud, a chain bucket excavator may be found to be the best tool. When clays and mud lying under water have to be gained, a grab is generally used, sometimes mounted on a pontoon. The choice of the tool will be governed by the conditions and the labour involved in its operation.

When flints are encountered in the chalk, they have to be removed before going into the wash-mill or else recovered from the wash-mill, if the chalk is soft enough to go direct into the wash-mill. In the former case the flints are removed on picking bands between the breaker and the wash-mills. This permits the wash-mill harrows to be of lighter construction and the power used in the wash-mill to be less, but the extra gear has to be provided and the labour costs are heavier than in the second case. When the flints are allowed to go into the wash-mill, a door, flush with its bottom, is provided for their removal, which takes place periodically. The door, when opened, allows the flints to slide down a chute to the boot of an elevator, which delivers them to a truck. The operation cannot take place till the wash-mill is emptied, and so entails an interference with the regular flow of the slurry from the wash-mill. The presence of the flints assists the breaking up of the chalk.

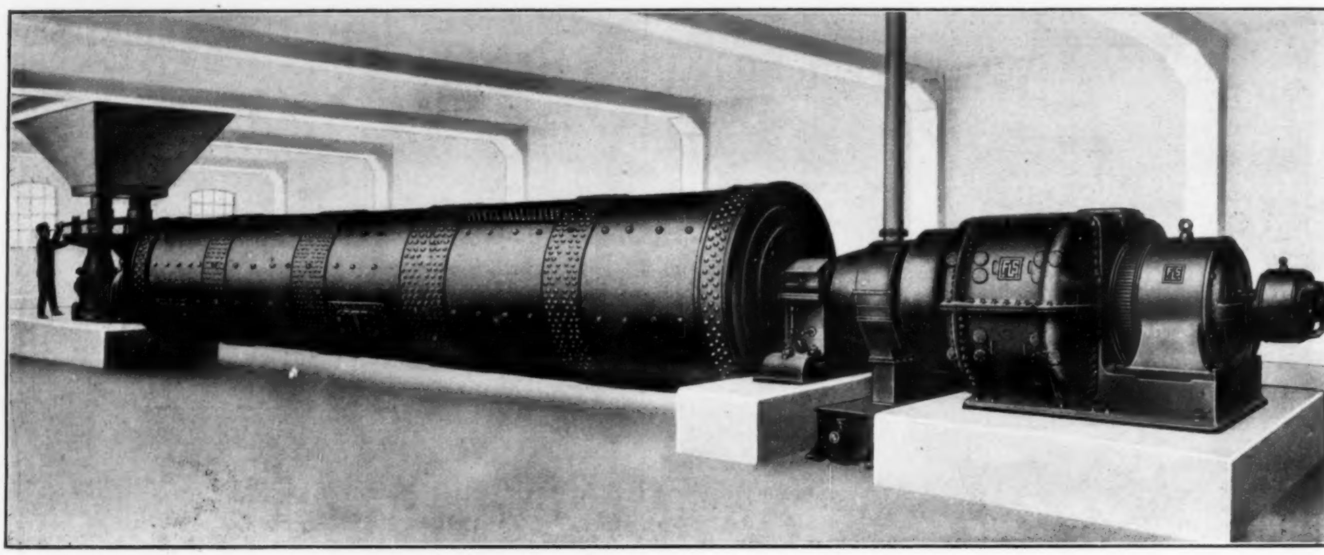


Fig. 11. View of Mill with Central Drive.

PREPARATION OF RAW MATERIALS.

The preparation plant is frequently operated for only eight hours a day, and storage has to be provided for this part of the plant to assure an adequate supply to the factory, which operates for twenty-four hours a day. Assuming that the shrinkage is such that $1\frac{3}{4}$ tons of solids have to be supplied to produce one ton of cement, and that the raw material plant works for eight hours a day and six days a week, the rate at which the raw materials have to be passed through will be about six times the rate of the cement output. Therefore, in a mill producing cement at the rate of, say, 16 tons per hour, the preparation plant must be arranged to prepare 96 tons of solids per hour, and, when operating on the wet process, 135 tons of slurry per hour.

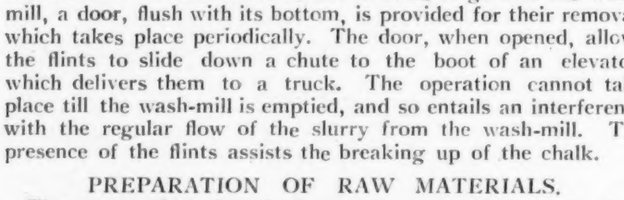


Fig. 12. Mill with Central Drive.

CRUSHING—HARD MATERIALS.

When crushing hard materials such as limestone and hard chalk, which are generally received from the quarry in lumps up to 2 feet in size, the first treatment is to reduce them to $1\frac{1}{2}$-inch size by passing them through two crushers in series. Two types of crushers are used, the "gyratory" and the "toggle-joint open-jaw" crusher. The former is of recent design and is now widely used in this country. An example is shown in Fig. 3. In this machine the crushing cone does not revolve but gyrates; in other words, the main shaft 5 is so supported by the central spindle 8 that the bottom is free to move in a circular course, in much the same way as a pendulum suspended in the usual manner. The pinion 31 is driven by means of the countershaft 32, to which is keyed the pulley 35, and the motion is transmitted to the bevel wheel 18, the latter being fitted with an eccentric boss revolving outside the hollow shaft 5.

The crushing cone is securely attached to the hollow shaft, so that it is constantly approaching and receding from the outside shell liners 27 and 28, and any stone coming between them is at once cracked and then released to settle lower down for another blow at the next gyration, or to be discharged if already fine enough. The cone is always crushing stone at some part of its circumference; thus the action is continuous, and a large output results. The gyratory motion imparted to the hollow shaft by the eccentric is naturally greatest at the bottom, and becomes less as the top is approached. Hence the motion of the cone is comparatively slight, and this fact, together with the concave form of the surface against which the stone is broken and the instant release after cracking, tends to prevent the shattering of the stone.

Fig. 4 shows a typical type of toggle-joint jaw-crusher. In this sectional view, 1 is the fixed-jaw face, 2 the swing-jaw face, 3 the swing-jaw stock, 4 the toggle seating, 5 the front toggle-plate, 6 the toggle seating, 7 the back toggle-plate, 8 the buffer springs, 9 the swing-jaw shaft, 10 the eccentric shaft, 11 the Pitman bush, 12 the adjusting bolts, 13 the Pitman, 14 the driving pulley, 15 upper extremity fixed-jaw face, 16 the toggle block, 17 the wedge block, 18 the fly-wheels, 19 the tension rods, 20 the cheek plates (top), 20a the cheek plates (bottom), 21 the body, 22 the swing-jaw bearing caps, 23 the Pitman bearing-caps, 24 the wedge for swing-jaw face, 25 the bolts for wedge, 26 the bolts for toggle block, and 27 the bolts for wedge block. When the raw material passes out of these crushers there may be some pieces larger than the required $1\frac{1}{2}$-inch maximum. These are rejected by a screen to a secondary crusher, from which they pass on to meet the main stream on its way to the storage bins.

SOFT MATERIALS.

Materials such as soft chalk, marl, clay, etc., are usually passed through rollers and then go direct into a wash-mill where they are reduced, with the addition of water, to a slurry.

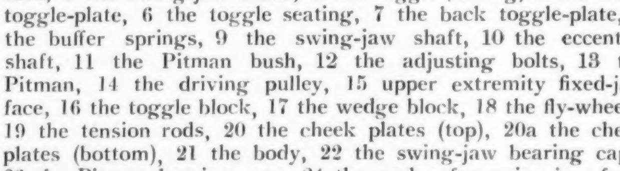


Fig. 12a. Coupling Rod with Muff Couplings.

A typical unit is shown in Fig. 5. It is composed of two opposing and interspaced sets of curved-toothed star-wheels which break up the materials in preparation for the wash-mill.

WASH-MILLS.

Wash-mills are generally of the harrow type with the harrows slung on chains suspended from a number of radial

arms which revolve in a horizontal plane. In the sides of the wash-mill are slotted screens, the width of the slots being generally from $\frac{1}{8}$ inch to $\frac{3}{16}$ inch; through these all the slurry must pass.

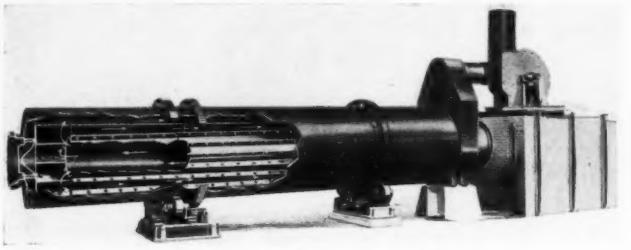


Fig. 15. Rotary Drier.

With soft washable materials, and when the quarries are some distance from the preparation plant, it is often more economical to roll and wash the soft materials into a slurry and pump them the required distance. In some of the plants in this country, the slurry is pumped as far as $3\frac{1}{2}$ miles. In suitable cases, it is possible to pump for this distance without having too high a pressure in the pumps and without the use of "booster" pumps, but this necessitates the use of a high percentage (about 70 per cent.) of water in the slurry. The finished mixed slurry as fed to the kiln will have from 34 to 45 per cent. of water, so that in the case of clay slurry containing 70 per cent. of water mixed with the chalk in a wash-mill, it may be possible, depending on the proportion of chalk to clay, to dispense with what are termed "settling backs." These are large tanks into which the thin slurry is pumped and which allow the water to run off as the particles of chalk or other material settle down. Weirs which can be raised or lowered are arranged at one end, and, by gradually lowering them, water free from the material can be drawn off.

STORAGE.

After having been crushed to $1\frac{1}{2}$ inches and less, the hard materials are passed to storage bins. These are usually built of reinforced concrete and are of a capacity sufficient to hold about three days' supply. In designing bins for the reception of materials of different sizes, it should be arranged that the materials are not drawn off directly under the point at which they were delivered from the discharging conveyor. When such materials fall they form a cone, the dust and smaller particles falling straight down while the larger pieces roll down the sides; thus, when drawing off from the centre of the cone, the dust will come first and the larger pieces afterwards, and the chemical composition of the resultant batch will be found to vary accordingly, so adding to the difficulties of the chemical control department, and tending to produce variations in the final mixture.

Raw materials in the form of slurry are stored in tanks generally built of concrete, and to prevent settlement taking place it is necessary to supply apparatus which will keep the slurry in a properly mixed condition. There are two satisfactory methods of doing this, the pneumatic and the mechanical methods. In the former, compressed air is supplied to the tank, and is arranged to discharge through several pipes at the bottom, thus thoroughly and economically agitating the slurry. The tank is made greater in height than in diameter, the proportions generally being about $2\frac{1}{4}$ to 1, and has an inverted conical bottom.

There are two types of mechanical mixers in use at present; one is known as the "sun and planet" mixer and the other is a mixer in which there are generally three vertical arms upon which suitable paddles are arranged. Both types are kept slowly revolving all the time. The "sun and planet" mixer is shown in Fig. 6. It comprises a large tank, generally from 30 to 66 feet in diameter and 8 to 12 feet deep, with a central concrete pier which supports the stirrer. The stirrer takes the form of a horizontal steel lattice girder which is supported at the centre of its length on a steel vertical shaft, and is free to rotate in a horizontal plane. Depending from the girders are four stirring arms arranged two on one side and two on the other of the central shaft, so that they are in balance. The four stirring arms are revolved by means of a motor (for a mixer of 66 feet diameter and 11 feet deep, holding about 1,500 tons of slurry, equivalent to about 600 tons of clinker, the motor would be of about 25 horse-power) which is placed at the centre, and drives the stirring arms through crown-wheels and pinions. The reaction between the revolving stirring arms and the slurry causes a slow rotation of the lattice girder so that not only do the stirrer arms rotate, but they revolve slowly round the tank. The result is that the whole of the slurry in the tank is continuously agitated and the solid matter in it is prevented from sinking to the bottom.

MEASURING APPARATUS.

There are many types of measuring machines. The materials, either wet or dry, can be measured by weight or by volume, usually the former. Every type should be automatic in action, capable of being calibrated and adjusted while in action, and should be of the recording type.

DRY MATERIALS.

If the materials are conveyed from the quarry by trucks, a weighbridge is employed which records the weight of each truck and its contents while the trucks are slowly passing over it. If the material is dry and is to be weighed when discharg-

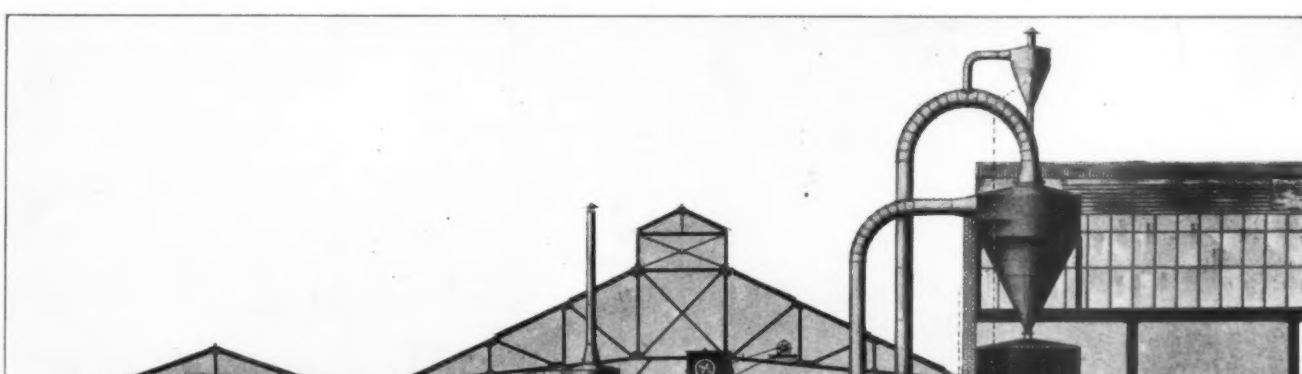


Fig. 14. Old Method of Preparing Pulverized Coal.

ing from the bottom of hoppers, one form of measuring apparatus is employed where a conveyor band is arranged to run over rollers carried on a frame which acts as a weigh-bridge. The machine shown in Fig. 7 is arranged to weigh the conveyor and the material upon it, in lengths of 20 feet and to record the weight of each successive 20 foot length, so that the material on every portion of the conveyor will be duly weighed.

decrease the delivery. The number of revolutions of the wheel is recorded and hence the amount of slurry can be calculated. Another type of measuring apparatus consists of a wheel rotating in a vertical plane and provided with buckets fitted to the end of hollow arms. The buckets dip beneath the surface of the slurry and, as they turn over the top, the material is projected down the hollow arms into a central chute.

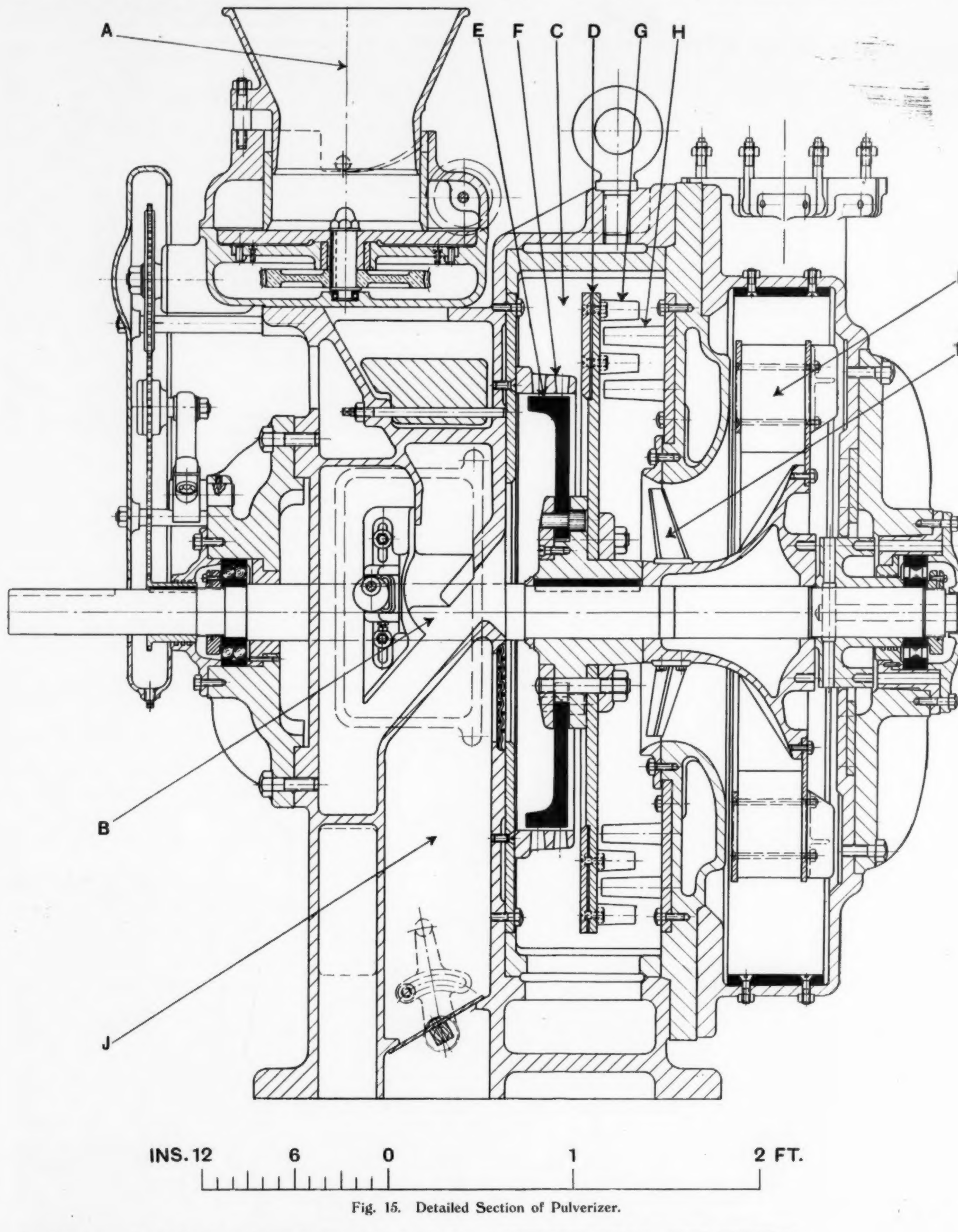


Fig. 15. Detailed Section of Pulverizer.

Another type of weigher is an intermittent automatic tipping hopper machine, and when a predetermined quantity has passed into one bucket, it is automatically tipped. This action causes another bucket to come into position for filling. The measurement of dry materials by volume is suitable in some cases.

WET MATERIALS.

When measuring materials in a wet state in the form of slurry, different apparatus is required. One apparatus consists of a series of buckets fastened to a rotating wheel; the buckets dip into a tank containing slurry at constant level and deliver a definite amount, as they pass over the top centre, into a chute. The height of the slurry, the angle of the buckets, or the speed of rotation of the wheel can be altered to increase or

GRINDING MILLS—WET PROCESS.

From the measuring apparatus the raw materials are mixed and fed into the grinding mill, water being added to the mixture at their entry into the mill. A "combination" mill is frequently the only type of mill that is employed to reduce the mixture from 1½-inch sizes to a thick slurry, and a typical mill of this type is shown in Fig. 8. It is tubular in form, mounted at each end on trunnions and revolved at about 25 revolutions per minute. It is generally divided into three or four compartments by cast-steel slotted diaphragms which permit the material to pass from one compartment to the next. The compartments are partially filled with balls or other grinding media, which are prevented from coming into direct contact with the shell by plates fitted all round the inner side. A

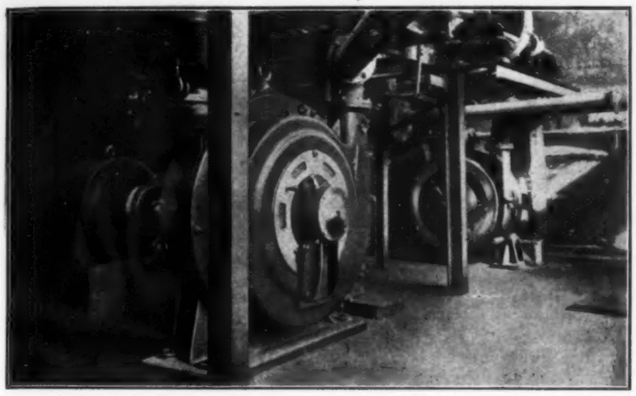


Fig. 16. Pulverizer on Firing Platform.

usual size of combination mill is one of 6 ft. 6 in. diameter and 36 ft. long, which would require a motor of about 350 h.p. to drive it, and would contain about 30 tons of steel balls. The crushed chalk or limestone is delivered on to a feed-table which supplies the mill at any predetermined rate. The material to be ground, and the necessary water, are fed into the hollow trunnion at one end and the ground slurry is passed out at the opposite end.

In some plants, the hard materials are ground by a "ball" mill, followed by a "tube" mill, although it is now more usual to treat them in a "combination" mill, which is a combination of the two. The ball mill is the preliminary grinder and can deal with most materials from 2 inches to 3 inches in size and reduce them to 20-mesh size. When used in the dry process it is fitted with sieves, but in wet grinding, the ground material, in the form of slurry, is discharged at the end remote from the feed out. The ball mill is partly filled with balls, the inside of the shell being protected with replaceable specially hard step-plates. A feed-table is generally used in conjunction with the ball mill. The relation of the diameter to the length of a ball mill is usually about five to three. Fig. 9 shows a ball mill in cross-section.

A tube mill consists of a horizontal rotary drum, about half full of balls or other grinding bodies of comparatively small diameter and of great hardness. The drum is supported on trunnion bearings, and rotates at a comparatively slow speed. The material enters through a hollow trunnion, moves through the whole length of the mill body while it rotates and is discharged at the opposite end of the mill in a pulverised condition. The tube mill is lined with special hard linings of various substances which have the property of resisting wear. The internal length of a tube mill is roughly four to five times its internal diameter, a usual size being about 31 ft. 6 in. in length and 6 ft. 5 in. in diameter, which would require about 250 horse-power. The output would depend on the amount of reduction of the material and its hardness. Fig. 10 shows a tube mill in section.

The grinding mills used in the dry process are similar to those used in the wet process except for the provision of sieves. One type of ball mill is arranged with sieves over the whole area of the shell behind the wearing plates. In another type, the material has to travel along the length of the mill and pass out through a number of circular screens fastened to the outside of the shell, the particles too large for the mesh of the screen being returned to the feed end of the mill.

There are two methods employed for driving combination and tube mills; one having spur-gearing fixed around the outside of the shell at the driving end which is engaged by a pinion, and the other a central drive direct on to the hollow trunnion. In the former, the spur-gearing is subject to considerable wear and tear, and has the disadvantage that it is difficult so to align it that it runs true; also, in practice it is impossible completely to exclude the dust. In the other method these disadvantages have been to a great extent overcome; the reduction gears are totally enclosed and run in an oil bath and the overall efficiency is higher. One type consists of a unit where the motor and gear-box are arranged on one bed-plate with a flexible coupling between the unit and the mill (Fig. 11). Another type is made where the motor is arranged to drive through the gear-box with a special long rod and muff coupling between the gear-box and the mill (Fig. 12). With central drive, the power is applied to the end remote from the feed end, whereas with the other type of drive the reverse is the case.

SEPARATING.

After the slurry has been discharged from the final raw material preparation mill, it is passed through a separator which rejects all particles larger than the predetermined fineness. This fineness is such that the residue on a 180-mesh sieve does not exceed about 3 per cent. The separator is generally of the centrifugal type, with a vertical spindle. The slurry is fed into the centre at the top, and is forced by the centrifugal action through screens placed vertically around the perimeter of the machine. The particles too large to go through the screens are returned for further reduction. Alternatively, a secondary wash-mill, with fine screens of 0.5-mm. slots, is used.

When the mixed slurry leaves the separator, it is passed to correcting mixers. There are generally three of these, mechanically agitated. The usual procedure is to have at all times one in course of filling, one being corrected for percentage carbonate of lime, and one being discharged to the storage at the kilns.

ROTARY DRIERS.

In the dry process the hard raw material and the soft raw material are crushed and rolled respectively, and fed to a storage hopper in a similar manner to the preliminary treatment of material being prepared by the wet process. After being discharged from the storage hoppers the materials are dried in a rotary drier and measured or weighed. Driers are of two types, direct-fired and waste-heat driers. An illustration of the former is given in Fig. 13. The principle and the construction of this type of drier are clearly shown in the sectional view. It consists of two long concentric steel-plate cylinders set with the delivery end slightly lower than the feed end, the gases from the drier furnace being taken down the central flue and then returned through the outer annular space, being finally discharged into the atmosphere by a fan. On entering the inner flue the gases are reduced, by the addition of air, to a temperature of about 1,350° F., and a great part of their heat is imparted to the inner shell, so that when they reach the outer shell they are at a temperature of about 350° F., while at the discharge they are reduced to 150° F. The loss by radiation is therefore very small since the outer shell is only in contact with cool gases, and the heat lost in the discharged gas is reduced to a minimum.

The material is fed into the outer annular space at the furnace end of the drier. Lifting flights are provided on the inside of the outer shell, and these raise the material to the top of the drier, thence dropping it on to the hot inner shell, where it is retained for the next half revolution by radial flights. The material in its wettest condition is therefore brought into intimate contact with the greatest source of heat. This operation is repeated over and over again, the material gradually working its way to the delivery end, due to the inclination at which the drier is set. The moisture evaporated is constantly carried away by the gases, and the material while passing along its long helical path through the drier is continually raised in temperature, until just before discharge it comes in contact with the dry gases.

The direct-fired drier has the great advantage that it can be placed anywhere, whereas the drier heated by waste gases from

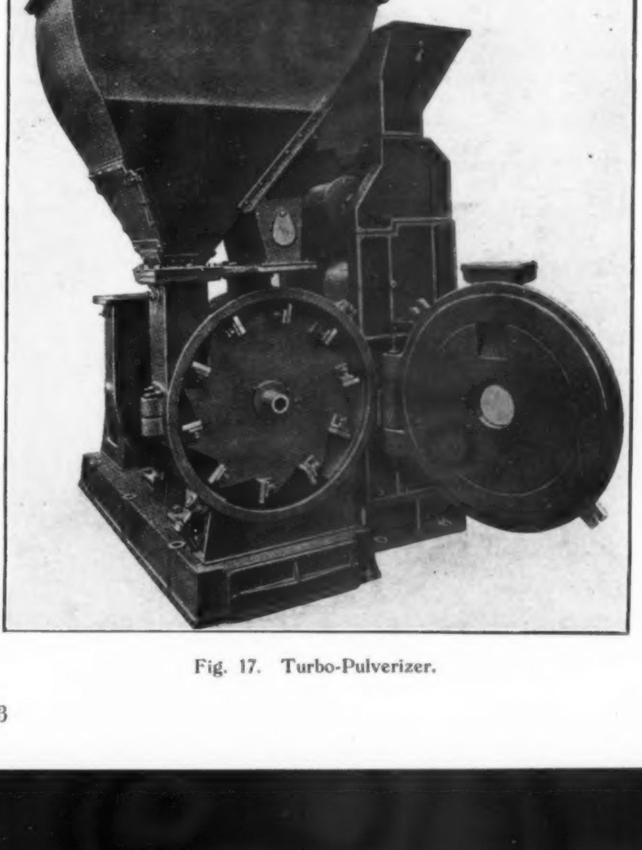


Fig. 17. Turbo-Pulverizer.

the kiln has to be arranged close to the gas exit of the kiln. Also, of course, the latter cannot be employed in plants where a waste-heat boiler for generating power is installed, and with intermittent working of the preparation plant, arrangements have to be made to by-pass the flue gases direct to the chimney when the drier is not in operation.

CONVEYING PLANT.

SLURRY.

There are five methods in use by which slurry can be handled: (1) plunger pumps, (2) centrifugal pumps, (3) elevators and conveyors, (4) gravitation, and (5) air lift.

(1) **Plunger Pumps.**—In this country, the plunger pump is most frequently used and takes the form of a 3-throw vertical pump with "A" frames. In one type there is a special arrangement to prevent the slurry from escaping through the packing gland. A water seal is arranged by fixing a loose ring under the gland packing with a series of holes or waterways opening out directly to the plunger face, the effect being to wash the plunger and keep a film of water between the slurry that is being pumped and the packing. The suction of the pump acting through an arrangement of cocks and non-return valves draws up the necessary water from the tank at the foot of the pumps.

(2) **Centrifugal Pumps.**—The use of this type of pump has the advantage that it can be driven direct by a motor, and is compact and light in weight compared with the plunger type, but difficulties in its operation due to attrition of the casings have prevented its use in this country. It should be constructed without stuffing boxes, a centrifugal seal being provided instead.

(3) **Elevators and Conveyors.**—A form of elevator which is frequently used is a slurry lifting wheel. This is simply a wheel about 30 feet in diameter with buckets, generally of elm, securely fastened to its perimeter. There is little to get out of order and the horse-power necessary to drive it is low. Slurry is also lifted by bucket-elevators, which generally take the form of a band-elevator with buckets riveted on. Ordinary screw-conveyers are also sometimes employed for handling slurry where there is only a slight upward inclination.

(4) **Gravitation.**—Whenever possible, the handling of slurry by gravitation is arranged. For this to be effective, the inclination of any chute must be above a minimum depending on the water content of the slurry.

(5) **Air Lift.**—In America, according to Meade,* an apparatus similar in principle to the pulsometer pump is employed. This consists of two receiving tanks set side by side into which the slurry flows by gravity. Each tank is equipped with a float which operates an air valve. The slurry entering the tank raises the float, and when the tank is full the float causes an air valve to open, allowing compressed air to flow into the tank and discharge its contents to the elevation required. This lifting apparatus has the advantage that there are few moving parts, but on the other hand it takes up a lot of floor-space, must be placed below the level of the bottom of the slurry tanks, and its efficiency is low.

DRY MATERIALS.

The conveying of dry materials can be arranged either mechanically or pneumatically. The types of mechanical conveyors and elevators used in cement making plant are common to any other trades, and do not call for special mention. The practice of conveying dry materials from sizes of ¼-inch cubes down to impalpable powder by pneumatic means is increasing rapidly. In America, in particular, this method is used extensively for the conveyance of cement, and in this country it is being realised that it has distinct advantages over mechanical conveyance methods under certain conditions. Especially is this so where all contact with uncontrolled draughts or moisture in any form must be avoided. Pneumatic plant in this respect has the distinct advantage that the system is closed.

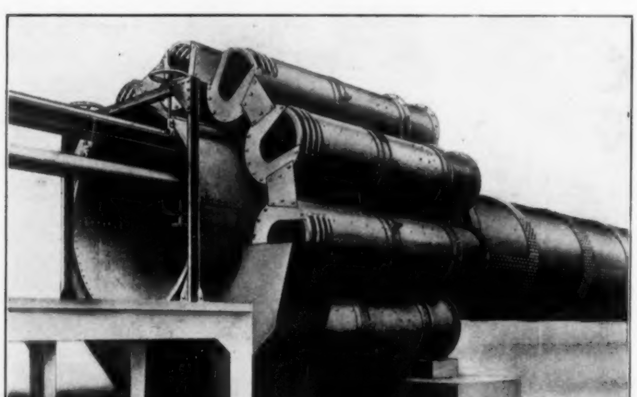


Fig. 18. Combined Kiln and Cooler.

* "Portland Cement," by R. K. Meade, U.S.A., 1926.

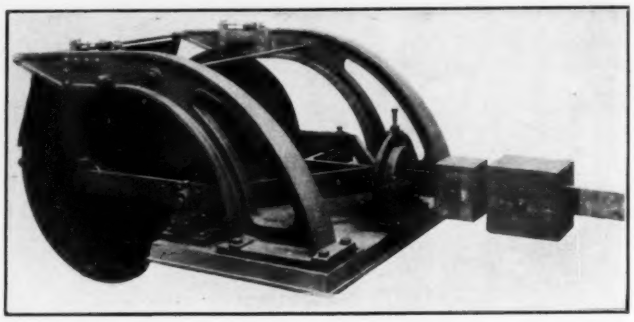


Fig. 19. Type of Automatic Clinker-Weighing Machine.

STORAGE OF FINISHED MIXED SLURRY.

The finished mixed slurry is contained in large mixers generally with a total capacity of 3½ days' supply for the kilns. These mixers have to keep the slurry in a properly mixed state and are either of the "sun and planet" type or air-agitated type, both of which have already been described. The total capacity of these mixers for a plant with an output of 135,000 tons per annum would be the equivalent of about 1,350 tons of cement.

ROTARY KILNS.

Rotary kilns are usually about 10 ft. in diameter by 250 ft. in length, but are sometimes constructed as long as 400 ft. They are made of steel plates from ⅝ inch to 1 inch in thickness with one to two sheets to make up the circumference according to the diameter. The joints are usually of the butt type, with external butt straps slightly thicker than the shell. The longitudinal joints are staggered to give uniform strength. A kiln is supported at two or more points on tyres. These tyres are not rigidly fixed to the shell but are fitted on shoes so that they are free to move around the perimeter of the shell. The shoes, which are somewhat similar to rail chairs, are riveted to the shell. To allow for longitudinal expansion each tyre runs on two large flat-faced rollers, the bearings being water-cooled. Thrust rollers are employed to keep the kiln in its proper longitudinal position.

The driving girth-gear takes the form of a spur-gear, generally in two parts which are mounted on tangential spring plates riveted to the shell. As the speed of the kiln is between the limits of ½ to 2 revolutions per minute, suitable reduction-gear is necessary. The upper end of the kiln extends into the "dust chamber," and arrangements have to be made to render the joint between the kiln shell and the dust-chamber wall as air-tight as possible. One method of doing this is to have a large flat ring at right angles to the shell, free to move laterally, and a casing on the dust-chamber wall to fit as closely as possible on each side of this ring. Thus the air can only enter by passing up one side of the ring and down the other, a distance which is often 10 or 12 inches.

The kiln is lined with refractory bricks for about three-quarters of its length from the firing end. Thence to the feed end there is usually inserted a system of curved plates which are designed to cascade the slurry so as to present a greater surface to the gases passing through the kiln. The thickness of the lining generally decreases the further it is from the firing end. In an uninsulated kiln, say of 9 ft. diameter and 200 ft. long, the thickness of the bricks for the first 80 ft. from the firing end would be 9 inches followed by about 15 feet of 6 in. bricks and 60 feet of 4½ in. bricks, the remaining 45 feet being unlined. For a kiln of this size a motor of about 50 b.h.p. would be required.

HEAT BALANCE OF THE ROTARY KILN AND COOLER.

Taking a rotary kiln operating on the wet process, the main items are as follows:—

(1) Heat necessary to decompose the $CaCO_3$ and $MgCO_3$ in the raw materials.
(2) Heat required to evaporate the water in the slurry.
(3) Heat required to raise steam made from the water from 212° F. to the temperature of the flue gases.
(4) Heat required to heat the flue gases, including excess air, to 212° F.
(5) Heat required to raise these to their temperature at exit.
(6) Heat lost in radiation from the kiln shell.
(7) Heat lost in radiation from the cooler.
(8) Heat lost on account of stoppages.
(9) Heat left in the clinker.
(10) Heat lost due to incomplete combustion.
(11) Heat required to warm the fuel and evaporate any moisture it may contain.

On the other side, which, of course, must balance the above, are the following:—

(1) Heat derived from the combustion of the fuel.
(2) Heat liberated during the formation of the clinker.
(3) Heat due to the temperature of the raw material.
(4) Heat due to the temperature of the fuel.
(5) Heat due to the temperature of the air.

On a six months' test of a rotary kiln operating on the wet process, in 1918, with an average flue gas temperature of 755° F., the flue gas analysis was, CO_2, 23.9 per cent.; O_2, 2.48 per cent.; CO, a trace; thus showing excess air amounting to 14.75 per cent. The moisture in the slurry was 37.6 per cent. and the temperature of the clinker leaving the cooler was 201° F. The fuel used averaged 26.53 per cent. of the weight of clinker, when reckoned as "standard" coal, whilst the $CaCO_3$ in the raw materials was 76.1.

The heat required was as follows:—(1) 7.83 per cent.; (2) and (3) 10.55 per cent.; (4) and (5) 4.53 per cent.; (6), (7) and (9) 13.36 per cent.; (8) 0.26 per cent. Total 36.53 per cent.

In this test the flue gas temperature was high, as with gravity feed and slurry lifters it should not exceed 600° F. The 37.6 per cent. moisture in the slurry was lower than usual in practice. The excess air could be below 14.75 per cent., and a good gas analysis would show from 2 to 1.5 per cent. O_2, no CO and the CO_2 as high as 25 or 26 per cent. This would give a thin white vapour. The temperature of 201° F. of the clinker leaving the cooler was high and could be reduced to about 180° F. To obviate the loss of heat from stoppages the best possible running hours should be maintained. A 5 per cent. stoppage allowance would be good over a long period.

Lewis and Radasch,* in a very thorough test on a rotary cement kiln 135 ft. long and 6 ft. 4 in. diameter, give a heat distribution as follows:—

	Per cent.
Heat Input	100
Heat Output—	
Heat of reaction	18.7
Sensible heat in gas	36.7
Potential heat in gas	0.3
Sensible heat in clinker	7.5
Heat required to charge	0.1
Heat to vaporize water in charge	0.3
Heat loss, by difference	36.4
	100.0

The last item of unaccounted heat lost includes heat lost by radiation and convection from the kiln shell and cooler.

Redgrave and Spackman† give the following average heat distribution:—

	Per cent.
Calcination	20
Radiation	20
Flue gases	40
Clinker	20
	100

In kiln operation the closest attention should be paid to the following points:—

(1) Keeping the temperature of the flue gases as low as possible.
(2) Reducing the water in the slurry to the minimum possible.
(3) Reducing the amount of excess air.
(4) Providing the most efficient cooler.
(5) Reducing the heat lost by radiation from the kiln.
(6) Maintaining the best possible running hours.

The perfect kiln on the wet process would need to comply with the following conditions:—

(a) That the kiln and cooler were perfect heat insulators.
(b) That the clinker going out of the cooler was at the same temperature as the slurry going in.
(c) That the hot gases passing out of the kiln were no warmer than was absolutely necessary to keep the water in the slurry in the form of steam at 212° F.
(d) That the air used for combustion and necessarily raised to 212° F, which would be the back-end temperature of the kiln, was neither more nor less than was required for the perfect combustion of the fuel in the kiln.
(e) That the amount of water in the slurry was as low as possible.
(f) That there were no solids carried out with the flue gases.

HEAT LOST BY RADIATION.

The losses from the kiln shell have within recent years received much attention, as it is recognised that a considerable amount of heat is dissipated in radiation and convection. Meade gives the results of an investigation on an 8 ft. diameter by 125 ft. rotary kiln burning wet materials which was divided into three zones, each 25 ft. long, at the feed end, followed by four zones, each 12½ ft. long, at the firing end. The total heat lost per hour was 3,905,640 B.Th.U's, while the output of clinker during the test was about 3.75 tons per hour. The heat lost per ton was therefore 1,040,000 B.Th.U.'s. The calorific value of the coal was 14,000 B.Th.U.'s per lb. and the consumption per ton of clinker was 707 lb. The total quantity of heat supplied by the coal per ton of clinker was 9,900,000, so that the loss by radiation in this case amounted to 10.59 per cent. of the heat supplied by the fuel. The percentage loss varies with the conditions; thus it has been found that the radiation loss from a horizontal surface exposed to wind is 30 per cent. greater, and of one exposed to wind and rain 70 per cent. greater, than when the surface is exposed only to still air.

To decrease the radiation losses from the kiln shell, there are two methods in use. The first is by housing the kiln throughout its length in a building. It is remarkable how often even this is not done, and it is no unusual sight to see kilns in this country quite uncovered and exposed to the elements, with a consequent large and unnecessary waste of heat. The second method is by the insertion of heat-resisting blocks between the refractory lining and the shell. This has been successfully and widely done in America and in other countries. Care has to be taken with the fitting and jointing of both the blocks and the bricks. At the firing end for the last 25 feet or so the heat-resisting blocks are discontinued, as it has been found in practice that the great heat in this zone attacks the jointing and there is a danger of collapse.

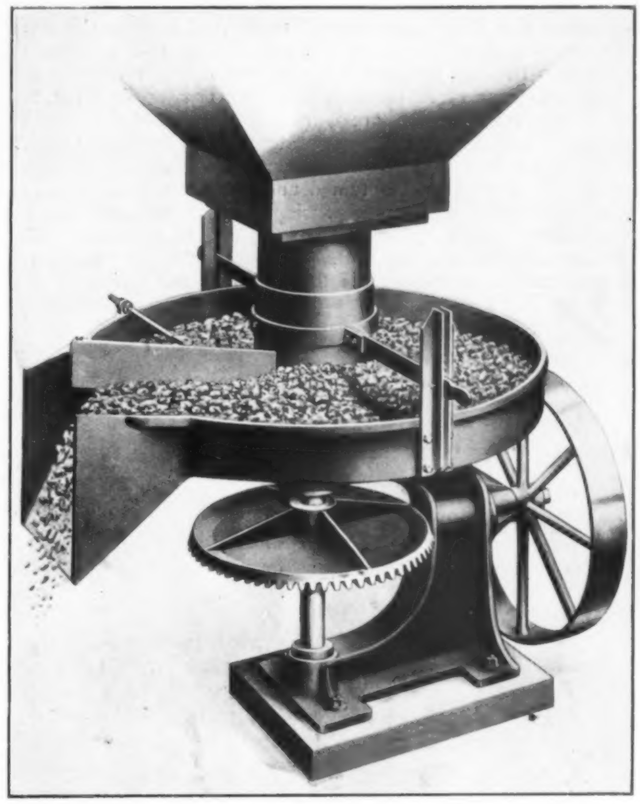


Fig. 20. Feed Table.

In a test on a rotary cement kiln, C. R. Darling* gives the following particulars: "The external surface varied in temperature from 400° F. at the hottest part to 150° F. at the entrance to the flue, the average being 280° F. The heat loss per sq. ft. per hour was therefore 610 B.Th.U.'s, and as the area of the exposed surface was 2,830 sq. ft., the total escape per hour was 1,726,300 B.Th.U.'s, equal in 24 hours to 2½ tons of the coal used. The heat escaping in 300 working days would, therefore, represent a loss of 750 tons of coal." The output of the kiln is not stated, but if it be taken that 630 sq. ft. of external surface is required per ton of clinker produced per hour, the output would be 4.5 tons per hour. With a coal consumption of 650 lb. per ton of clinker, the loss expressed as a percentage of the total cost used would be 8 per cent., or 6d. per ton of clinker produced with coal costing 20s. per ton.

If, by the insertion of insulating blocks behind the firebrick lining, the external surface temperature were reduced to, say, an average of 180° F., then by the Darling curve 300 B.Th.U.'s would escape per sq. ft. per hour, or the loss would be approximately half that occurring when the average temperature was 280° F. Meade states that the insertion of a 3 inch layer of insulation blocks probably reduces the radiation losses to from 25 to 50 per cent. of what they would be without it. Brobston* found that when a brick cut from diatomaceous earth was placed between the shell and the firebrick lining in the upper part of the kiln on a plant where waste-heat boilers were used, the insulation raised the temperature of the flue gases 150° F. ,and where waste-heat boilers were not installed the insulated kilns required 30 to 60 lb. less coal per ton of clinker. He adds that insulating bricks cannot be used in the burning zone as they are destroyed in from sixteen hours to four days, but that this zone could be insulated with carborundum were the cost not prohibitive. It is not practicable to lag the kiln shell on the outside, for if this were done the kiln shell could not be inspected for signs of overheating, showing that the lining has become too thin, that rivets have become loose or that cracks or bulges have occurred in the shell.

LOSS IN FLUE GASES.

Another large loss of heat occurs in the flue gases. This is in the neighbourhood of 42 per cent. of the heat of the coal burned. Arnold† states that approximately 45 per cent. of the

* "Industrial Stoichiometry," by W. K. Lewis and A. H. Radasch, New York, 1926, pages 95 et seq.
† "Calcareous Cements," by G. R. Redgrave and C. Spackman, 1924.

* "Engineering," 1913, vol. 96, page 643.
* "Mechanical Engineering," 1922, vol. 44, pages 517-518.

total heat in the coal, as fired in insulated kilns, is delivered to waste-heat boilers by the flue gases.

In some other countries waste-heat boiler installations are used to recover part of this heat and to turn it into useful work, but in this country it is not the practice. According to H. A. Schaffer*, of the Portland Cement Association, only eight cement mills in America had waste-heat boilers in 1919, but in 1924 thirty-five waste-heat plants had been installed and a further eight were under construction. The loss of heat due to the temperature of the discharged clinker will be discussed later under the heading of "coolers."

KILN FEED.

It is in connection with the reduction of heat losses in the flue gases that the "atomising" method of feeding the slurry into the kiln is of particular interest. Instead of pouring the slurry into the kiln through a pipe placed nearly vertically, it is forced under pressure through spraying nozzles into the feed end of the kiln. There are generally two or three nozzles, which are capable of being set at different angles, and the slurry pressure can also be altered, so that the maximum amount of dispersion is obtained and the greatest surface area is exposed to the flue gases passing through the sprays. The great advantage in principle lies in the increase of surface exposed with the gravity feed, and the consequent greater rate of heat transference from the flue gases to the slurry.

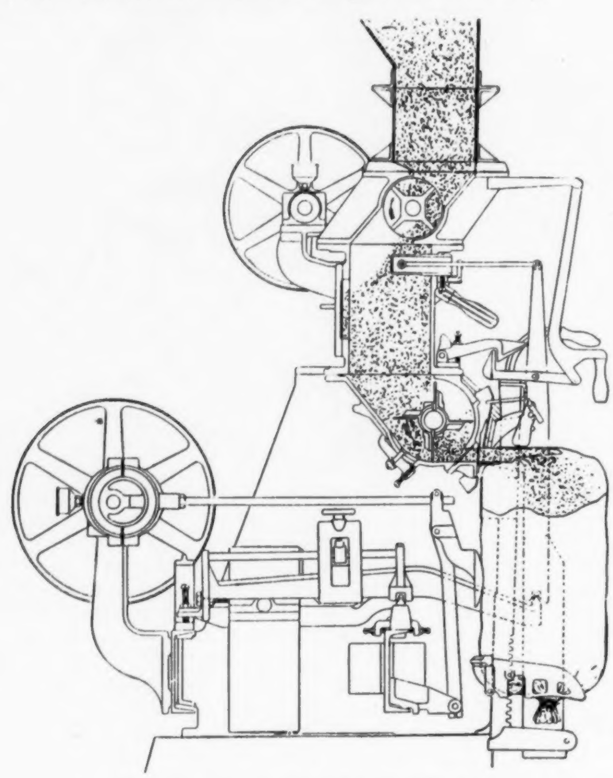


Fig. 21. Mechanical Bag-Filling Machine.

During the passage of the raw material through the kiln various changes take place, which may be divided roughly into five zones, starting at the feed end.

First Zone.—In this zone, in the wet process, the slurry enters the kiln at about 12° C. (53.6° F.), the water is evaporated, and the material is raised in temperature. In the dry process, only the dry materials have to be raised in temperature. In this zone various secondary reactions occur, such as the liberation of the combined water in the raw materials, and the burning of the sulphur and organic matter.

Second Zone.—In this zone the dried raw materials are heated to a temperature at which the calcium carbonates commence to decompose. This occurs in a comparatively short distance as the temperature rises very rapidly. This zone is termed the "heating" zone.

Third Zone.—This zone is called the "calcining" zone, where the CO_2 is gradually given off, the process being complete when the temperature reaches 1,100° C.† The giving up of CO_2 results in a marked reduction of the weight of the material.

Fourth Zone.—In this zone, named the "sintering" or "clinkering" zone, the lime, alumina and silica unite at between 1,100° C. and 1,500° C.* to produce the mixture of calcium silicates and aluminates which comprises Portland cement clinker. An exothermic reaction takes place adding to the heat in the kiln.

Fifth Zone.—This zone is termed the "firing" zone where the temperature declines as it meets the warmed air necessary for combustion coming from the cooler or other source.

EFFECT OF ATOMISING FEED.

By the introduction of the atomising feed system, according to a description given in "Engineering" (1926 vol. 121, page 681), the effect of the spray feed is that the drying and heating zones are considerably shortened, as instead of 57 per cent. of the length of the kiln, only about 40 per cent. is required, with the result that, as the sintering and firing zones are of the same length in both systems, the calcining zone is increased from about 30 to 47 per cent. A greater output of clinker is claimed as a result of the longer calcining zone with the same length of kiln, or a reduction of fuel for the same output. Conversely, the length of the kiln could be shortened without decreasing the output. In the article referred to, it is stated that a kiln 206 ft. long could be reduced to 166 ft. by adopting the atomising method, without reducing the output. Also that the life of the kiln lining appears to be somewhat prolonged owing to the absence of slurry rings and the smaller size of the clinker tends towards lower grinding costs.

The lower final temperature of the exit gases from the kiln, which to be with gravity feed is in the neighbourhood of 400° C., is stated with atomising feed, about 150° C. This comparatively low final temperature would dispose of one problem which has always faced the designer of cement plants, that is how to employ economically the large amount of heat that, with the gravity feed, passes to waste up the chimney. Waste-heat boilers to generate steam for the power supply require a temperature at the inlet to the boiler of about 600° C. (1,112° F.) in the wet process and 700° C. (1,300° F.) in the dry process. With a temperature in the neighbourhood of 150° C. (300° F.) the employment of waste-heat boilers, in the form they exist to-day, is not likely to be economical. This method of feeding the kilns is at the present time in course of development in practice, and its progress will be watched with interest.

FUEL SUPPLY TO KILNS; PULVERISED COAL.

The coal, before it is in a suitable condition for burning in a kiln, has to go through a series of treatments. As received, it will have a moisture content of from 8 to 15 per cent.; it will be in sizes from fine dust to lumps of 2 inches or more, and it will sometimes be mixed with pieces of metal in the form of iron spikes, etc. It must be prepared so that, at its entry into the kiln it will be in such a state of fineness that the residue on a 100 × 100 standard screen (10,000 meshes per sq.inch) after 15 minutes' continuous shaking, will not exceed 5 per cent., and on a 180 × 180 standard screen (32,400 meshes per sq. inch) will not exceed 15 per cent.

The older method of carrying out this series of treatments was to do them separately; the coal was crushed and dried, metallic substances were separated, it was pulverised, stored and blown into the kiln, each by a separate unit. This method necessitated a considerable amount of plant, capital outlay and heavy running costs, as will be appreciated by an inspection of a typical lay-out of the older method shown in Fig. 14. A is the track hopper and conveyor, B is the coal crusher, C the raw coal elevator, D is the raw coal hopper, E the feeder, F the conveyor, G the furnace for the rotary drier, H the magnetic separator, J the exhaust fan for dryer, K the cyclone separator for dryer, L the rotary coal dryer, M the dried coal elevator, N the dried coal hopper, O the pulverising mill, P the exhaust fan for the pulverising mill, Q the cyclone separator for pulverised coal, R the supplementary cyclone separator, S the pulverised coal hopper, T the feeder for pulverised coal, U the blower for firing kiln, V the rotary kiln, and W the rotary cooler.

In the later method, all of the treatments are performed by a coal pulveriser generally preceded by a coal drier. The pulveriser is placed directly behind the kiln to be served and is on a level with the firing platform. It is usually placed on its own separate foundation so that any vibration will not be communicated to the platform. The unit machine, therefore, receives the coal, separates all metallic or other heavier-than-coal substances, pulverises it, and finally delivers it direct into the kiln. Hot air from the clinker cooler at a temperature of about 400° F. is drawn into the machine and comes into contact with the coal during pulverisation, and as a result raises its temperature. A rejector is also arranged so that all particles above a certain size are returned to the machine for further treatment. The power required is about 14 to 15 kw.-hrs. per ton of coal pulverised.

In one type of pulveriser shown in Fig. 15, the coal from the hopper A descends on to a variable feeder and then falls down a passage in the body of the pulveriser to the metal separator B. Here the coal is met by an air current, the velocity of which carries it into the pulverising chamber C, but allows the metal and stone to fall to the base of the machine. The rotor D divides the chamber into two parts. On the inlet side there is a number of hammers E freely pivoted to the hub. When in action, these are held out by centrifugal force and beat the coal through the screen F, whence it is carried by the air stream to the second stage. Here the fine pulverising is carried out,

† "Power," 1926, vol. 64, page 232.
* "Power," 1924, vol. 59, page 150.
† Otto Dorman, "Neue Gesichtspunkte zur Beurteilung des Kohlenverbrauchs in Zementdurchrohrofen," Ton-Industrie Zeitung, 1914, vol. 38, page 1,741.
* William Poole on "Limes and Cements," Trans. Inst. of Engineers, Australia, 1924, vol. v., page 101.

the elements consisting of alternate rows of moving and fixed pegs G and H. The hot air for drying the coal enters through the passage J. The rejector K separates the coal that has not been sufficiently pulverised and returns it to the machine. The end casing contains a fan, L, which blows the pulverised coal and air direct to the burners.

In Fig. 16 is seen the method of arranging a pulveriser on the firing platform, showing the piping direct to the kiln hood on the right. In a second type, shown in Fig. 17, the same duties are performed, but in a slightly different manner. This machine consists of a single pulverising chamber into which the large coal is fed. It is reduced by paddle-like beaters and passed into the separator. The stream of coal and air is spread out and delivered in a horizontal direction and the suction connection of the fan is placed at right angles to the stream. In this way the fine particles are drawn from the separator and the heavier particles travel on and are returned to the pulverising chamber. To regulate the fineness a deflector is provided in the separator, arranged so that the steam of coal and air may be directed so as to make it more or less susceptible to the suction of the fan.

CLINKER COOLERS.

The size of the usual type of rotary cooler depends on its complementary unit, the kiln, and ranges from 5 ft. diameter by 50 ft. long to 8 ft. diameter by 80 ft. long, the horse-power necessary being about 10 to 15 respectively. There are two alternative positions for the cooler with respect to the kiln; either the cooler is set on a continuation of the same axis as the kiln, or it is doubled back underneath it. In either case the hot clinker at about 1,148° C. (2,100° F.) falls by gravity into the cooler through the movable kiln-hood; it is cascaded inside the cooler and delivered to the clinker conveyor. Each kiln is provided with a cooler so that the whole represents one unit.

The cooler is lined in various ways partly with firebrick and partly with lifting plates, depending on individual design. At the delivery end it is sometimes perforated for the last three or four feet to act as a rotary screen, the lumps unable to pass through the $1\frac{1}{2}$ inch to 2 inch holes being discharged over the end to a separate heap. Alternatively, the discharge end of the cooler has lifting plates so that the clinker is discharged at or near the top of the discharge end, thereby saving 4 or 5 feet of height.

The heat content of each ton of clinker at 2,032° F. is (2,032-32) × 2,240 × 0.246 = 1,100,000 B.Th.U.'s, equivalent to the heat value of about 92 lb. of coal of 12,000 B.Th.U.'s per lb., and if it is assumed that each ton of clinker requires about 650 lb. of coal, this represents about 14 per cent. of the whole. If the cooler had a thermal efficiency of 100 per cent., this large amount of heat would be transferred to the air passing through the cooler on its way to the kiln, but losses take place due to the heat radiated from the cooler shell and to the heat going out in the clinker. The loss of heat by radiation is about 35 per cent. of the heat in the clinker entering the cooler, that is, 385,000 B.Th.U.'s.

If the temperature of the clinker leaving the cooler is taken at 230° F. and the specific heat at 0.246, the heat contained in each ton of it will be (230-32) × 2,240 × 0.246 = 109,000 B.Th.U.'s. The combined loss will be 385,000 + 109,000 = 494,000 B.Th.U.'s, and the remainder, 1,100,000—494,000 = 606,000 B.Th.U.'s is transferred to the air. This gives a thermal efficiency of 55 per cent., and the saving resulting from the use of a cooler is about 7.7 per cent. of the fuel used. H. A. Schäffer states that the recovery of heat from clinker at a temperature of about 2,100° F. by preheating the combustion air results in a saving of 7 to 8 per cent.

One type of cooler recently introduced in this country is a distinct departure from ordinary practice. It takes the form of a combined kiln and cooler. The kiln follows the usual practice, having at the firing end a portion which is of considerably larger diameter than the kiln tube, and it is in this that the clinker is cooled. The cooler comprises a series of tubes arranged around a central cylinder which is an extension of the kiln tube. It is provided with a thin lining of refractory heat-insulating material and is closed at the end remote from the kiln with a cap or hood of similar design to the firing hoods of ordinary rotary kilns. Kiln and cooler, being rigidly connected, revolve together as a single unit.

In this type a separate cooler is unnecessary, the piers to support the kiln, and consequently the kiln building, can be much lower than is the case with the usual type of kiln and separate cooler. It is claimed that this type of kiln is more efficient thermally than the usual type for the following main reasons: (1) the cooling of the clinker is more efficient, and (2) the loss of heat from the clinker in passing to the cooler is much less. The makers give the result of a works test abroad where a coal consumption of 22 per cent. of British standard coal was realised with a slurry containing about 40 per cent. of moisture. An illustration of this type is given in Fig. 18.

AUTOMATIC WEIGHING MACHINE FOR CLINKER.

It is usual to provide a weighing machine for the clinker as it emerges from the cooler. This machine has to be capable of continuously weighing clinker at a temperature of 110° C. and at any rate at which it offers itself. It must also record the weight passed through. One type of weigher used is an automatic weighing machine which receives the clinker into one of four compartments of an open drum capable of revolving. This drum it at one end of a lever, and on the other end is an adjustable weight, one balancing the other through a fulcrum. When any compartment is filled to the predetermined quantity, the weight is overcome, and the drum descends. This action causes the release of the drum and, being itself out of balance, it rotates a quarter of a turn and discharges. Each downward movement of the balance lever actuates a counter from which the amount of material passed through is recorded. Fig. 19 shows this type of weigher.

The clinker weigher discharges the clinker on to a conveyor, which conveys it to open air or bin storage. It has been found that when clinker is "seasoned," that is, after it has been exposed to the elements for a definite period, it is somewhat easier to grind. Whether it is economical to do this or not depends on conditions obtaining at the mill, such as the space available, the capital cost of extra plant, the cost of the double handling, and the extra amount of clinker always carried in storage. The clinker is fed downwards through a feed table, one type of which is shown in Fig. 20, in the grinding mill.

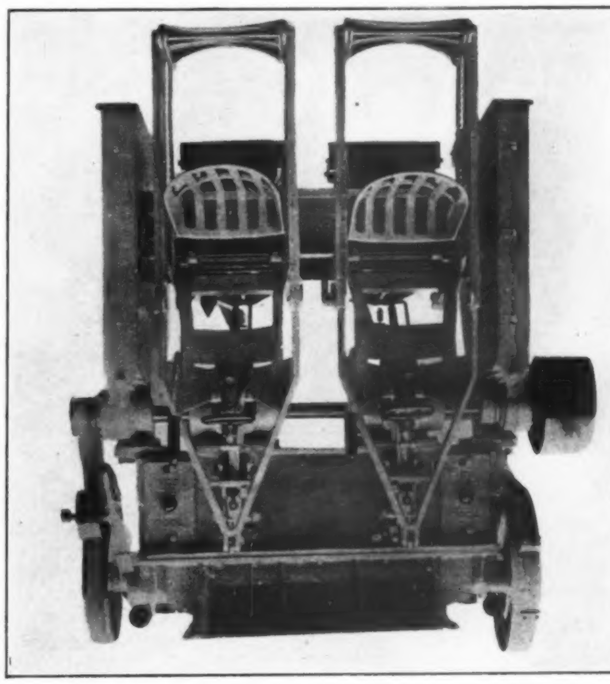


Fig. 22. Mechanical Bag-filling Machine.

GRINDING AND STORAGE PLANT.

The degree of fineness to which cement, to conform to the British Standard Specification, has to be ground is such that on a 180 × 180 standard screen (32,400 meshes per sq. inch or 5,022 meshes per sq. cm.) after 15 minutes' continuous sifting the residue shall not exceed 10 per cent., and also that on a 76 × 76 screen (5,776 meshes per sq. inch or 895 meshes per sq. cm.) after 15 minutes' sifting the residue shall not exceed 1 per cent. In practice it is usual to grind the clinker to a greater degree of fineness than that which meets the requirements of the British Standard Specification as, within limits, the finer the grinding, the stronger will be concrete in tension and compression. A fineness of 5 per cent. on the 180 × 180 sieve and no residue on a 76 × 76 sieve is common, and for special specification this can be reduced to 2 per cent. or less on a 180 × 180 sieve.

The finer the cement, the more is the power required to grind it; as a rough rule, the power required is directly proportioned to the fineness, that is, it takes approximately twice the power to grind to $2\frac{1}{2}$ per cent. as to 5 per cent. fineness. When a fineness of $2\frac{1}{2}$ per cent. is required in a combination mill, the rate of feed would be reduced to about half the rate at which the mill is fed when a 5 per cent. fineness is required.

The types of mills used for grinding clinker are similar to those used for grinding the hard raw materials. The usual type is the combination mill, which has already been described. Great care has to be taken to protect adequately the driving motor and the coupling and reduction gear of the mill from the fine cement dust. It is usual to have a dust-proof non-inflammable wall between the mill and the motor, and to install a dust-collecting apparatus. A usual size of combination mill is 6 ft. in diameter by 32 ft. 6 in. long inside the tube. Two slotted cast-steel diaphragms, permitting the passage of the material, divide it into three compartments. The first two of these are lined with stepped plates of chrome steel. The last, or finishing compartment, which is the longest, has a special cast-iron lining. All contain steel balls, the total weight of

which is about 25 tons. Those in the first compartment are 3 inches or 4 inches in diameter, while the finishing balls are 1¼ inches or 1 inch in diameter, the middle chamber containing an intermediate size.

A mill of this size requires a motor of about 500 h.p. to drive it through reduction gear at about 25 r.p.m., and the output, grinding to a 5 per cent. fineness on a 180 × 180 sieve, would be about 6 to 7 tons per hour.

CEMENT STORAGE.

Adequate arrangements must be made properly to protect the finished cement from the effects of moisture in any form, at all times. The cement may possibly be in the storage silos for months and any small degree of moisture allowed to come into contact with it would be deleterious. Moisture may be carried in by draughts of air, and protection against these must be provided.

Silos are made of ferro-concrete, or of steel, and although the latter may be slightly cheaper in capital cost, and more quickly erected, they need more attention than silos constructed of ferro-concrete, and require periodical painting. The total capacity for cement storage usually provided is about six weeks' output. The number of individual silos making this total may be, in the case of a mill producing 150,000 tons per annum, six or eight of capacities from 250 to 4,000 tons each.

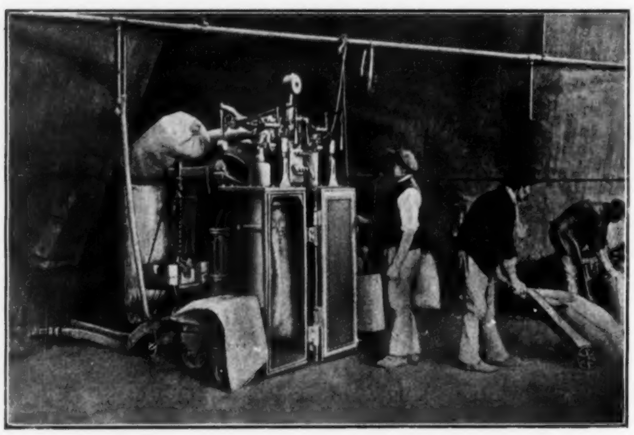


Fig. 23. Pneumatic Cement-Packing Machine.

PACKING.

There are two systems by which the cement is packed, the mechanical and the pneumatic systems. One type of mechanical packer or bag-filling machine requires a cement bag with what is called a "valve." This valve is at one bottom corner of the bag, and is made by doubling in and sewing a small portion of the bag. Into this valve is inserted the discharging tube of the packer, and when the bag is filled and the tube withdrawn the weight of the cement in the bag effectively closes the valve.

In Fig. 21 it will be seen that, from the supply bin of 10 or 12 tons capacity, the cement flows to the hopper of the machine through a spider which prevents the flow of cement into the hopper when the machine is not running. From the hopper the cement is forced by the feeder blades through the filling tube into the bag. These feeder blades revolve at about 1,000 r.p.m. The bag rests in the saddle of the bag chair which is suspended on one end of the balance-scale beam. When the bag contains the desired weight of cement the scale beam is forced down and the flow of cement is cut off. The operator then pulls forward the discharge lever and the bag falls forward on to the carrier belt. Fig. 22 shows the front view of the mechanical bag-filling machine.

In one type of pneumatic machine, advantage is taken of the fact that in fine powder form cement can be conveyed along a pipe without admixture of extra air, by creating a vacuum at one end of the pipe. The material is extracted direct from the silo simply by connecting a pipe from it to the machines, in which a vacuum is created. The sack or cask is clamped inside the machine, an airtight door is closed, and the air pressure is reduced. When the sack or cask is filled and weighs a predetermined amount, the supply of cement is automatically cut off, the door springs open and all traces of dust are removed by a fan so that none escapes to the surrounding atmosphere.

The machine is made with two compartments as shown in Fig. 23; one door fixed in the centre is used alternately to close each compartment. It is connected directly to the silo by a flexible tube and also to the vacuum pipe-line. It is mounted on wheels so that it can be moved from one silo to another. One man can operate a two-compartment machine which will pack and weigh about 11 tons of cement per hour, with two men in attendance for tying up the bags and wheeling away. This type packs sacks, paper bags or iron or wood casks.

ELECTRICAL TREATMENT OF A CEMENT MILL.

Owing to the scattered nature of the units requiring power in a cement works, it is the universal practice to employ electricity for the distribution of the energy. With electricity, economies over any other form of power are possible, owing to its ease of transmission to distant points which permits of a central-station supply either on the works or from an external source of supply. It also has the advantage that the power taken by each motor can be accurately measured and any irregularities are readily indicated.

SELECTION OF SYSTEM.

Alternating current, of either 25 or 50 cycle, three-phase, is generally used in preference to continuous current for cement works, particularly when the total power is large and permits of the employment of turbo-alternators. If the mill is provided with its own power house, there is the choice between high pressure (say, 2,000 to 6,000 volts) for the large power motors with transformers to reduce the pressure to 440 volts for the numerous small motors, or a low pressure of 440 volts throughout the works. When an external course of supply is used it is possible to consider the voltage of supply for each motor on its merits. The supply would probably be taken at 6,600 volts, but sometimes at 3,300 volts; the larger motors of 500 h.p. for the grinding mills and other heavy duties would be wound for the high tension supply and transformers would be installed to reduce the pressure to 440 volts for the numerous small motors. Which motors should be wound for the high pressure and which for the low resolves itself into a question of finance, and much will depend on the individual motors and the method of grouping. Generally speaking, it is not economical to instal motors wound for high pressure unless they have an output of at least 150 to 200 h.p.

TYPES OF MOTORS.

Practically all the motors in cement works, except those for the smallest sizes, require a high starting torque. Kilns and mills of all descriptions possess a great amount of inertia and friction which call for at least twice the full-load working torque. For slurry pumps, conveyors, elevators, mixers, sack-drying plant, squirrel-cage motors are usually installed, as it is found that the one-third full-load starting torque (which they give with star-delta starters) is sufficient for the running torque. The slip-ring motor gives a higher starting torque, but in small sizes it is much more expensive than the squirrel-cage type. If efficiency and power factor are not held highly to account, there is a lot to be said in favour of the slip-ring motor. It is a wise precaution so to arrange the horse-power of the motors as to have as many as possible of the same power so that the mimimum of spares need be carried.

SWITCH-GEAR.

As in cement works, there is always a certain amount of cement dust in the atmosphere, it is desirable to use as far as possible a switch-gear of the oil-immersed type. For controlling the starter of slip-ring motors, an oil-immersed switch with overload release meets the case, while for squirrel-cage motors, oil-immersed star-delta starters with a complete "off" position are suitable. All the motor starting equipments should be fitted with adequate overload and no-volt release.

POWER.

The amount of power required per ton of cement produced depends on the following main factors:—

(1) The hardness of the raw materials.
(2) The position of the quarries.
(3) The process which is employed.
(4) The fineness to which the cement is ground.
(5) The design of the works.
(6) The load factor.
(7) The overall efficiency of the works.

The electrical energy required is between 65 and 100 kw.-hrs. per ton of cement; therefore a factory producing 100,000 tons of cement per annum would require from 6.5 to 10 million units per annum.

DISTRIBUTION OF POWER.

If the raw materials are hard, the power absorbed in their grinding may take as much as 35 per cent. of the total power required by the whole plant. The clinker grinding mills may take another 45 per cent., leaving only 20 per cent. for all other units. The following list will roughly indicate where the power is absorbed in a mill using hard raw materials:—

Department.	Per cent.
Crushing	6
Grinding	33
Kilns	5
Coal Mill	11
Clinker Mills	40
Miscellaneous	5
	100

In a mill using soft chalk and clay, the power required per ton may be 20 per cent. less than in a mill using hard raw materials.

In conclusion the Author wishes to acknowledge the help he has received in the preparation of the Paper from those who have supplied him with information and illustrations of plant, particularly Messrs. Edgar Allen & Company, The Celite Products Corporation, Messrs. Clarke, Chapman & Company, Messrs. Hadfields, Messrs. Alfred Herbert, Messrs. Ruston & Hornsby, Messrs. F. L. Smidth & Company, Messrs. Tractor Traders, and Messrs. Vickers.

Harbour Engineering Notes.

MOTORS FOR TRACTION SERVICE.

Considerable attention is now being devoted to the design and construction of motors for traction service, and the excellent results already obtained by motors specially designed for railway work are noteworthy, in view of the policy of main line electrification both in Europe and America. On the Spanish Northern Railway, for instance, 22 freight locomotives are being installed, and the motors of these locomotives are of interest. The conditions of operation laid down for the overload tests were 900 amps. at 1350/3 volts. with 62.5 per cent. field current during one minute, with the motor warm.

On the test bed the motor was subjected continuously to a current of 900 amps at 1350/3 volts with 62.5 per cent. field current for ten minutes, starting cold. During the trials, the heating reached only about 60 per cent. of the maximum permissible value. At 1.8 times nominal pressure, there was no sparking at the commutator, and when the current was raised to 1,200 amps at nominal pressure there was no sparking.

The complete motor, made by the Ateliers de Construction Querlikon, weighs 6,720 lb., or 30.3 and 22.7 lb. per K.W. for the one-hour rating. The corresponding weights per lb. tractive effort at the periphery of the armature are 4.84 and 5.72 lb. Considering the fact that motors for " tram suspension " have to be of very substantial construction, it will be seen how advantageously these machines have been constructed, and to what degree every part has been utilised.

SOUND-ABSORBING PLASTERS.

Interest is being shown by constructional engineers in the progress made by the Bureau of Standards in their researches into the possibility of developing sound-absorbing plasters for use in theatre auditoriums and similar buildings to prevent the excessive reverberation often produced in such rooms by the high reflecting power of ordinary plaster. It is estimated that such surfaces should absorb up to 15 per cent. of sound. Plasters made with a porous aggregate such as pumice have been used already, though they present certain difficulties in application and require very careful treatment.

It has so far, however, been ascertained that by mixing small amounts of alum and lime carbonate with a dry mixture of calcined gypsum and sand, an easily worked plaster having the required surface porosity is obtainable. When the plaster is wet, the carbonate and alum form carbon dioxide, which produces many small bubbles of gas in the plaster. Various fine aggregates have been tried, but up to the present, calcined diatomaceous earth, pumice and tufa give the best results.

DIESEL ENGINES AS CENTRAL STATION GENERATING UNITS.

The Diesel engine is widely used abroad as a standby in central generating plants, and also, in many cases, as the main generating units, and the success obtained at the Shanghai station in the French Concession has directed attention to the possibilities of this form of generation for large industrial stations. At Shanghai, all the electricity for the public lighting, tramways and other services is generated by Diesel engines, the largest being a 5,000 b.h.p. stationary two-cycle Sulzer Diesel engine, electricity being generated through fly-wheel type Oerlikon and Schneider alternators.

Following the success obtained at Shanghai, the Hamburg public electricity supply station installed last autumn a nine cylinder double acting two-stroke M.A.N. Diesel engine of 15,000 h.p. This engine works on the reversing scavenging principle and is coupled to the generators through friction clutches. Since its installation this engine has put in six to eight hours work daily, the average fuel consumption working out at 0.59 lb. per kilowatt hour. It is used chiefly for taking up the morning and evening peak loads, and has been put into operation within four minutes, while, in the event of a boiler breakdown the Diesel electric set has been supplying current to the system within six minutes. During normal working the set has supplied a peak load of 10,500 K.W.

The engine works at the low speed of 95 r.p.m., the installation being regarded largely as an experimental one, and it is of interest to note that the capital invested in the Hamburg plant amounted to as much as £15 per K.W. of finished plant. It is proposed to instal two similar engines in the Hennigsdorfer station at Berlin.

LARGE DIESEL LOCOMOTIVES.

Diesel electric locomotives have been applied with great success to various railway operations, though the large Diesel locomotive is something of an innovation as far as express passenger traffic is concerned. In this connection it is of interest to note that a Diesel locomotive for fast passenger and goods trains will be put into operation on the Boston and Maine Railroad early in the spring.

This locomotive is carried on two bogie trucks, the wheel arrangement being four leading, eight drivers and four trailers. The engine used is a non-reversible four-stroke six-cylinder type of 1,400 b.h.p. with solid injection. The engine operates on the four driving axles through a starting clutch of the hydraulic type and a four stage reduction gear with a special reversing mechanism. It is estimated that the tractive effort on the first stage of gear reduction will be approximately 46,000 lb., and the maximum speed of the locomotive will be in the neighbourhood of 60 miles an hour.

COMMERCIAL BERYLLIUM.

A process developed by the Siemens and Halske Company in Germany for producing beryllium on a commercial scale by the electro-chemical process promises to place this metal at the service of engineers in appreciable quantities. A future for the metal had already been prophesied in the sphere of light alloys, beryllium being only about two-thirds of the weight of aluminium.

Apart from this advantage beryllium is extremely hard, harder in fact than glass, and it has the melting point of over 1,200 deg C. At the present moment beryllium has not been found in very large quantities and, until the advent of the Siemens and Halske process, the cost of production was very high. Results already obtained with beryllium alloys, however, show that it can be drawn into very thin sheets and it is also highly malleable.

ELECTRO-DEPOSITION OF RUBBER.

The manufacture of various commercial articles in rubber by the electro-deposition process has already been perfected by Dr. S. E. Sheppard in America, it being claimed by the inventor that rubber goods made in this way have greater durability and toughness than those manufactured by existing processes, and also that the costs of production are cheaper because lighter machinery can be used, the space requirements are smaller and the automatic nature of the process renders unnecessary a large proportion of the skilled labour normally employed.

The essentials of the process consist in passing an electric current through rubber latex, together with the various softeners, fillers and other agents according to the nature of the goods being made. Moulds of the desired shape are inserted in the mixture and the rubber is deposited therein. An important point is that the mixture of rubber and the agents remains unaffected during the process. The method is similar in all respects to the ordinary electro-deposition of metals, though it is stated that it is much more rapid than, for instance, nickel-deposition, the same amount of current serving to deposit a coat of rubber 1,400 times as thick as one of nickel.

Port of Southampton Topics.

1927 IN RETROSPECT.

When, in the future, the history of Southampton as a port is written, much space will have to be given to recording the advances made in 1927, for the year was one of unfaltering progress. Principally, perhaps, it will be remembered as having seen the beginning of work on the long-considered and oft-amended scheme for dock extension. The work on this scheme, which is estimated will entail an expenditure of £13,000,000, has not been so rapid as some anticipated, but greater strides are expected to be made during the present year. The first work undertaken was the widening of the road which, when complete, will provide adequate motor and railway communication between the existing docks and the new. At the same time dredging on the new deep water channel which is to link up with the old channel was commenced. The reclamation work carried out between the Royal Pier Train Ferry Jetty, where the contractors will have their base when the construction of the docks proper begins, has been watched with general interest. Early in the year a retaining wall was built along this site and into the space between this and the old sea wall the spoil from dredging was pumped. By this means 18 acres have been filled in and when ultimately the new docks are completed this space will be handed over to the local authority for use as a recreation ground. That these new docks are really necessary was brought home during the year by the fact that in the existing docks it was difficult to find accommodation for a large number of ships which have been added to the large liner services.

All previous records were eclipsed in the traffic returns for the docks during the year, and under no heading is a falling-off in activity shown. Seven per cent. more passengers used the port, and there was an increase of 4 per cent. in tonnage. The amount of cargo handled was 2 per cent. in excess of last year's total. The fact that 31,533 more passengers sailed to or from the port indicates that Southampton is well maintaining her position as premier passenger port and in addition the efforts of the Southern Railway to popularise the port as a

cargo centre are shown to have borne fruit. The cargo figures have jumped by 25,000 tons. Indeed, an increase in this trade has been one of the features of post-war years for last year's figures for cargo export are 73 per cent. above those of 1919. The number of vessels inward during last year increased from 3,211 to 3,460, and outward from 3,209 to 3,456. The gross tonnage rose from 14,595,166 tons inward and 14,674,704 tons outward to 15,203,400 tons inward and 15,165,000 tons outward. Cargo imported showed an increase of from 632,264 tons to 647,250 tons, and the export figure increased from 527,739 tons to 537,750 tons. Some idea of what progress these figures signify can be obtained from a comparison with the statistics for 1913. In that year the gross inward tonnage was only 8,784,032 tons against last year's 15,203,400 tons. The net tonnage inward in 1913 was 4,420,904 tons. In 1927 it was 8,066,770. In pre-war years, however, the cargo trade was greater and the total exports and imports for 1913 were 1,319,523 tons against 1,185,000 tons last year.

TWO NOTABLE ACHIEVEMENTS.

For local shipyards the year was one of the best experienced in the history of the port, the most notable achievement being that of Messrs. J. Thornycroft and Co., Ltd., in securing, in the face of competition from 20 firms, the contract for building six seagoing destroyers, for the Chilean Navy. This contract was worth over a million pounds, and is furnishing a great deal of work for men of the shipbuilding trades. Messrs. J. Samuel White, of Cowes, whose interests are intimately associated with Southampton had equal cause for satisfaction in securing an order to build three flotilla leaders for the Argentine Navy. This is the first time since the war that naval orders have been placed in Britain by foreign powers.

A CLOSER CONNECTION.

So impressed were the management of the Nederland Royal Mail by the success of their decision to bring the majority of their homeward vessels into the docks at Southampton that they have decided to still further extend the scheme. Last year the vessels more or less regularly occupied a berth in the docks during the summer months but at other times of the year passengers were landed by tender, except when the number to be landed was considered to justify bringing the vessel into the docks. This year, however, the minimum number of cabin passengers to determine that the vessel shall be docked has been reduced and it is likely that all the line's homeward steamers between February and September will be dealt with in the docks.

HARBOUR BOARD TOPICS.

A gradual silting up has been taking place towards the entrance of the Itchen River, on the banks of which much of the cargo traffic and shipbuilding activity centres. The bank which has formed was thought likely to affect adversely this riverside work and the Harbour Board at their last meeting decided to remove the shoal and to maintain hereabouts a channel 200 ft. wide, adequate for allowing the passage of the smaller type of vessel which uses this waterway. Later on another shoal existing at the edge of the swinging ground is to be removed. At the same meeting the Harbour Board is to assist the Royal Motor Yacht Club and British Motor Boat Club in the proposal to establish Southampton as the headquarters for fast motor boat racing in England. The Board's support was subject to the shipping of the port not being interfered with and to arrangements being made in respect of dredging operations.

Port of Havre Affairs.

NEW GANTRY CRANES.

The first of the four cranes, ordered from Messrs. Caillard and Co., of Havre, by the Port Authority for the new berths of the "Quai Joanne's Couvert," was successfully tested on December 23rd, 1927, under the supervision of the Port Engineering Department.

This new type was designed last year by the firm of Caillard et Cie, when tenders were invited by the Port Authority. It shows some entirely new features to meet the particular requirements of the Port Engineers in dealing with the cargo of the French liners ss. *Ile-de-France* and ss. *Paris*, when loads have to be lifted over the hatches 30 metres above quay level and 20.45 metres away from the quay wall.

This great height and radius, together with the small space available round the hatches and on the quay made it necessary for Messrs. Caillard et Cie to use the level-luffing principle in their design and the device they evolved makes the working of the crane quick, safe and cheap.

The gantry has a span of 9.30 metres and carries a pyramidal structure on top of which rests the revolving part.

The jib is as light as could be and is balanced at any angle by means of an appliance located on the top of the control cab. The luffing axis can be seen on the photograph on the same level as the cab roof. A small jib has been fitted on the big one to prevent the load from swinging when either luffing or slewing. The winding load is 2 or 5 metric tons according

New Gantry Crane, designed and built by M.M. Caillard et Cie, ready to unload a big French Liner berthed at the "Quai Joanne's Couvert," Havre.

to the gear used. The maximum radius is 27 metres and the minimum, 11 metres. The lifting speed is 0.60 metres for a load of 5 tons and 1.50 metres for a load of 2 tons. The slewing speed is one revolution per minute, with a level luffing speed of 1.50 metres per second. The travelling speed of the gantry is 0.20 metres per second.

HISTORIC GOLD CARGO.

On Friday, January 6th, an historic gold cargo was landed at Havre in the shape of gold ingots of a total value of two millions sterling.

The bullion which weighed about 15 tons was brought from the United States by the ss. *Rockampton* of the French Line. It was loaded in less than one hour and afterwards brought to Paris and immediately deposited at the Bank of France.

The gold was part of the cash reserve accumulated in the United States during the past few years by the Bank of France in accordance with the orders of the French Treasury.

TRANSATLANTIC AIR MAIL.

The Latécoère Company will start their Transatlantic air postal service between the Argentine Republic and Europe on March 1st.

SEAPLANES FOR LINER.

Special appliances for despatching seaplanes from the ss. *Ile-de-France*, of the French Line, are now being fitted on board this liner and it is thus hoped to save considerable time in dealing with the mail when approaching port.

CHERBOURG CHAMBER OF COMMERCE.

M. Quonian, who has already done so much for improving Cherbourg Harbour, has been re-elected President of the Chamber of Commerce, which body acts as Port Authority.

CARNARVON HARBOUR TRUST.

The Carnarvon Harbour Trust Works Committee has had under consideration the report of the Surveyor regarding schemes of repair to the dock wall, damaged by the recent storm. Tenders are to be invited for carrying out the work. A committee was appointed to draw up the specifications, etc., and make a report.

TYNE SHIPBUILDING ACTIVITY.

An event which is unusual, if not unique, in the history of shipbuilding occurred on January 28th, when no less than four vessels were despatched from the shipyards of Sir W. G. Armstrong, Whitworth and Co., Ltd., in a single day.

Among these vessels was the 10,000 tons cargo liner *Beaverdale*, one of two similar vessels built by the firm to the order of Canadian Pacific Steamships, Limited.

The Development of Bluff Harbour.

Proposals for the Improvement of Facilities at this New Zealand Port.

INTRODUCTION.

THE following proposals for the improvement of Bluff Harbour, New Zealand, are the product of research by Mr. Robert Adams, Assoc.M.Inst.C.E., engineer to the Bluff Harbour Board, and were embodied in a Report presented by him to that Authority in August, 1926.

The location of Bluff Harbour, or Awarua, the Port of Invercargill, is in lat. 46 deg. S., long. 168 deg. 30 mins. E. The exports comprise frozen mutton, beef, wool, hides, tallow, grain, timber, sheep and rabbit skins, New Zealand flax, rabbits, preserved milk, and agricultural implements. Invercargill has a population of 16,000, and Bluff 1,832.

GENERAL.

The general complaint raised against this port is that it lacks modern facilities, and that the Board has done nothing, or very little, for the shipping in return for the revenue it has received. A port like Bluff cannot be expected to provide the up-to-date equipment that one finds at home ports. I note that some time ago the Port of London Authority had authorised the expenditure of £4,000,000 on a scheme, but their enormous trade warrants such enormous expenditure.

The provision of port facilities should generally only be considered from a point of view of efficiency. In dealing with the question of efficiency I should say that the object to be arrived at is to enable any business to be conducted with the least ultimate cost. This must take into consideration the cost value of delays.

Dealing with the provision of facilities at a port, the question of efficiency will be governed by amount of cargo to be handled. In a manufacturing business the provision of up-to-date equipment increases the output and at the same time decreases the unit cost. But in our case the provision of expensive cargo handling appliances, etc., is not going to materially increase the amount of goods to be handled, because practically all the Southland trade comes through Bluff at present. In the one case, equipment is provided to increase output, but in the other case it would be false economy to provide the equipment to handle the output until such output grew to a stage to warrant the expenditure on the handling equipment. Complaints have been made that this port lacks facilities and cargo handling appliances. On several occasions, where complaints have been made of the lack of facilities, I have observed that, had the facilities been provided for rapidly loading or unloading vessels, there would have been congestion and delay with the railway trucks. I have also observed vessels taking in cargo faster than the trucks could get the goods from the ship's side. The Board will have to weigh carefully the question as to whether its volume of trade warrants a heavy expenditure on improved facilities. Will such facilities make the port more efficient?

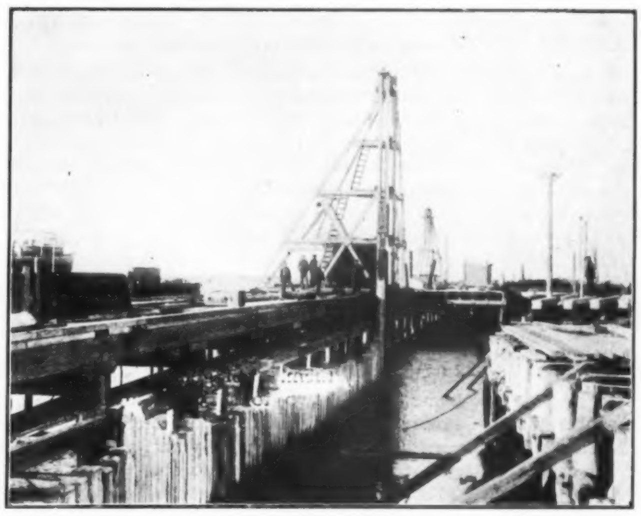
REQUIREMENTS OF A MODERN PORT.

A modern port should possess the following features: It should have a sheltered area of water with an entrance from the sea that has ample width and depth of water, with a safe approach free from adverse currents, shoals and reefs or other obstructions. The entrance and approach from the sea should be so situated that vessels can make the harbour in safety in storms and at the same time give protection to the harbour from the open sea. Sometimes the above requirements are provided for by Nature, sometimes a natural harbour is improved in one way or another to give the above requirements, while in many cases artificial harbours have to be constructed with or without the aid of Nature, and sometimes even in the teeth of Nature, the provision depending upon the necessity for a sea outlet for the trade of the locality.

Whether the harbour is natural or artificial, aids to navigation have to be provided in the way of buoys, beacons and lights, etc., to mark the channels and approaches, signalling facilities to give communication with the shore, means of directing navigation during fogs by means of wireless direction finding and submarine sounding devices, etc., pilotage facilities and towing equipment, together with an efficient organisation to control and operate these facilities. Some form of government is necessary, and in New Zealand this takes the form of a local governing body or Harbour Board, subject to Government supervision. Other countries have various systems of management, some ports being owned and controlled by private enterprise. The Harbour Board controls the policy of the port, levies dues on shipping and goods using the port, provides for building and improvement programmes and maintenance of facilities, makes by-laws and fixes the various charges. It controls the financial operations of the port and provides the necessary organisation to carry out the various operations necessary for its proper control.

Where possible, anchorages are provided for vessels awaiting a berth, and where no berthage is provided, vessels are worked by means of lighters. This method is in vogue at Colombo, handling 2,000,000 tons of cargo per annum, where provision of a harbour has been a very expensive item. Ample berthage accommodation is provided where possible by means of quays and wharves with or without the various facilities such as transit sheds, cargo handling appliances, etc. A supply of electricity is usually provided for lighting and power purposes, and the port authority generally controls the supply of water for the shipping.

It is essential that a modern port has lines of communication with civilisation by means of railways, roads and telephones and, where practicable, a system of canals and coastal communication is also provided. Facilities have to be provided for Customs and medical examinations, and in large ports that handle a great number of overseas passengers special provision is made for their convenience by means of special passenger landing stages, such as at Liverpool.



Driving Concrete Sheet Piles in Bluff Harbour, New Zealand.

The depth of water and width of entrance will depend upon the type of shipping to be catered for. In large harbours a width of entrance channel is allowed up to 1,200 ft. with a depth of from 30 ft. to 36 ft. at low water. One of the latest wet docks built in London has a floating depth of 38 ft.

The type of shipping to be catered for will depend upon the nature and volume of the cargo to be handled, together with its destination. Also the cargo handling facilities provided will also depend upon the nature and volume of the cargo to be handled. It must be borne in mind that modern large cargo vessels have a very efficient equipment of cargo handling appliances of their own. This is made necessary owing to the fact that a large number of ports have very little or no cargo handling equipment. It is modern practice to provide transit sheds where possible, which act as reservoirs or accumulators to even out the flow of cargo. Sorting and Customs operations are carried out in these sheds. These are distinct from storage sheds, or warehouses, which are sometimes provided in addition. Also, it is necessary to have an ample supply of suitable labour available to carry out the various duties in connection with the working of the port. In some important ports provision is made for the docking and repairing of vessels. It is the exception to find ports that can be worked at any state of the tide by the largest vessels that they can accommodate.

It is very necessary that the modern port should have efficient connection with the railway system of the country. In large Continental and American ports this is a serious problem on account of the enormous amount of traffic handled. To obtain efficiency it is necessary to obtain co-operation between the railway and port authorities with benefits to both. In railway working, shunting operations are very costly, and increase with an increase in goods handled.

Also these operations cause a good deal of delay and congestion. A Port Authority should so design its works as to minimise the necessity for shunting. The control of the railway traffic at the ports of this country is exercising the minds of the

authorities, and some are of the opinion that it should pass into the hands of the Port Authority at a certain point.

Although viewed with disfavour by the railway authorities at some ports such as ours, it is undoubted that road transport is necessary to the efficient operation of a modern port. The railway is essentially a system of transport for long haulages on account of the terminal charges being relatively high in comparison with the haulage charges, so that the shorter the haul the greater the cost per ton mile. When the cost of double handling the goods at the terminal is added to this, the motor lorry is able to offer a much more efficient and speedy means of getting goods from place to place where the haulage is short. The distance from Invercargill and Bluff is only a short haul, and nothing near the distance required to give the railways an undisputed advantage over motor transport. If the railway tariff is made so that it can cope with the motor competition on such a short haul as this, then it is at the expense of the long distance goods. There should be no serious opposition from the railways to the motor taking the short haul work, as this is the work that generally does not pay them. Up to the present the motor is not in evidence at Bluff because it cannot get the goods to the ship, although I have seen goods brought down by road and loaded on to the railway trucks to get them to the ship's side. Given the facilities at the port, and provided it is given a fair run by the Government and not hampered by restricted legislation, there will be a surprising development of road transport to the benefit of all, including the railways. The fact that the Government at present holds a monopoly over the Bluff traffic will tend to make them put unnecessary obstacles in the way of motor transport.

At Continental and English ports an enormous amount of cargo is handled in barges on account of the low cost of water transport.

MODERN CARGO HANDLING APPLIANCES.

A modern type electric dock crane to lift a load from three to five tons is a very efficient piece of machinery, but, like most modern machinery, its efficiency depends upon the use made of it. If only used occasionally it becomes an expensive luxury. Very seldom do the dues received from cranes pay for the cost of installing and operating them, and the deficiency has to be met from general revenue. As these cranes have a working radius up to 60 ft. they have to be heavily built to give stability. Cranes to lift from three to five tons will weigh from 50 to 60 tons, and will give a maximum concentrated load on the wharf of from 20 to 25 tons under one leg. On account of the height that they have to lift goods to clear modern vessels, their superstructure is very high above deck level, and this necessitated a very rigid structure to carry them. For general work, a crane with a capacity from one to two tons is favoured by many engineers, whilst others favour the three ton crane, and the five ton crane is often installed. As a rule, a wharf will not carry these cranes unless specially designed to do so.

It is recognised that modern ship's gear is very efficient, and the main point that it is beaten on by the cranes is its limited command of the wharf. The modern practice is to use the ship's gear and the cranes together in the same hold in order to obtain rapid working of the cargo, the crane enabling the goods to be placed on or picked up from a much greater area on the wharf than the ship's gear. The cranes have to be in the charge of skilled operators.

When specialised goods are handled in bulk, special appliances are used, such as conveyors and transporters. To move the goods about on the wharf, hand-trucks and tractors and trailers are used. Provision is made for handling the goods in the transit sheds, and may consist of portable cranes, overhead travelling cranes and other lifting and stacking devices.

GEOGRAPHICAL.

The Port of Bluff is situated at the south end of the South Island, the approximate geographical position being lat. S. 46 deg. 37 min., and longitude E. 168 deg. 22 min. Like a good many other ports it suffers, from a commercial point of view, in that it is not a convenient distributing and collecting centre, and therefore functions purely as a port and a necessary appendage to its supporting city. As the port for the City of Invercargill, which city is situated 17 miles away by rail, it is the gateway to the whole of Southland, there being no rival ports to compete with it. It is the port of entry and departure for passengers to and from Australia for the South Island. It is closer to Melbourne and Sydney than the other four main New Zealand ports. It forms the connecting link between Stewart Island and the rest of New Zealand.

PHYSICAL DESCRIPTION.

The Bluff Harbour consists of an irregular shaped, well-sheltered tidal basin, having a water area of about 22 square miles at high water, the entrance being short, narrow and rock-bound. The main approach channel from the open sea consists of a submerged estuary, well sheltered, free from bars or other obstructions, of ample width and carrying not less than 40 ft. at low water up to the entrance of the harbour. The outside of this channel is protected by the Davy Bank, which arrests any heavy seas and prevents them from entering the harbour. During heavy storms vessels can obtain a good sheltered anchorage at Stewart Island. Good depths are obtained in the entrance with the exception of a few isolated rocky patches which are surrounded by deep water, the depths being generally over 30 ft. The prevailing wind is about due west, from which direction the heaviest winds generally blow. The main wharf is so placed that ships are berthed practically head-on to these winds. The currents flow in such a way inside the harbour as to maintain a deep-water channel past the main wharf and on to the entrance.

IMPROVEMENTS CARRIED OUT.

In 1905 the main wharf carried a maximum depth of 26 ft. at low water, while to-day the depth has been increased to 30 ft. When it is remembered that this improvement has necessitated the removal of a large quantity of hard granite, mud and sand amounting to over two million tons, the magnitude of the work will be realised. Huge quantities of sand amounting to over 712,000 tons have been dredged from the middle bank, so that there is now adequate swinging room for vessels up to 550 ft. in length. A total of 2,000 tons of hard granite rock was blasted and dredged from the Mararoa Rock in the entrance, the depth over this rock being increased from 19 to 24 ft. at low water. Also rock has been blasted and dredged from the Channel Rocks. Blasting work is still proceeding in the channel, the object being to give increased depths. The results of all this work, which has kept an up-to-date dredging and other plant busy for over twenty years, is not evident to the casual observer on account of it not being visible. Suffice it to say that the harbour of twenty years ago would not be able to cope with the size of the vessels now catered for, either for swinging room or depth. A system of buoys, leading marks, beacons and lights has been installed, together with pilot and signal stations. The wharfage accommodation has grown, until to-day the main wharf has a length of 1,800 ft., and a new wharf of 1,000 ft. long is nearing completion. An area of four and a half acres of land has been reclaimed, on which has been erected modern cool stores with a capacity of 75,000 crates of cheese, 20,000 boxes of butter and 10,000 boxes of fish. Bulk oil storage tanks are being erected on part of this land. Also a small slipway is under construction.

In addition to the above, the Board has acquired a modern ladder and suction dredge—Priestman dredge, Lobnitz rock-breaker with 15-ton cutter and air compressor and pneumatic tools, modern pile-driving plant, and efficient tug and various floating gear, including well-equipped diving gear and a workshop equipped with modern tools.

PRESENT FACILITIES.

The port to-day possesses all the necessary facilities for handling its shipping with the exception of up-to-date cargo handling appliances and transit sheds. An adequate supply of water from the Board's own reservoir is maintained at the wharf, and there is also an efficient supply of electric light. Berthage accommodation is provided for vessels up to 550 ft. in length and drawing up to 29 ft. 6 in. at low water. The main wharf is 1,800 ft. long, and the new wharf will be 1,000 ft. long. These wharves are constructed of hardwood timber, the piles being muntz metal sheathed.

Large cool stores for cheese, butter and fish are maintained adjacent to the wharf owned and operated by the Southland Cool Stores Co.

There are large private wool and grain stores with private sidings, giving rail access to the main wharf. The Board maintains the passenger service between Bluff and Stewart Island, and has recently placed a contract with Messrs. Vickers (New Zealand), Ltd., for an up-to-date combined passenger vessel and tug, having twin-screw semi-Diesel engines with a total brake horse-power of 1,200 and a working speed of 12 knots. This vessel will replace the existing steam tug of 500 h.p. The Board maintains its own pilot service with signal stations, etc. The port is connected with the main South Island railway system, the lines going right to the ship's side. Practically the whole of the freight is handled by the railways. The total lengths of the rails on the main wharf amounts to approximately two miles. The port is also connected with Invercargill by road.

TRADE OF PORT.

The trade of the port has grown from a small beginning, until to-day about 150,000 tons of cargo is handled each year. The size of vessels using the port has steadily increased from the small sailing vessels of the olden days, until to-day modern steamers over 520 ft. long up to 64 ft. beam and drawing over 29 ft. call here. Vessels visit the port from all parts of the world.

Both from a shipping point of view and the quantity of cargo handled, the trade of Bluff is very intermittent, as is shown by the accompanying diagram. This is usual with most ports. There is the possibility that the effect of Control Boards will make this even more so, and there is also a possibility that the number of overseas vessels visiting the port may not increase with the expected increase of cargo owing to each vessel taking bigger loads from each port visited. The following tabulation shows the relative position of Bluff to other New

Zealand ports from the point of view of total tonnage of cargo handled for the year 1925:—

No.	Port.	Total tonnage of cargo.
1.	Auckland	1,875,606
2.	Wellington	1,685,948
3.	Lyttelton	727,078
4.	Westport	573,464
5.	Dunedin	473,899
6.	Greymouth	292,830
7.	Napier	214,291
8.	Wanganui	189,924
9.	New Plymouth	178,207
10.	Whangarei	171,382
11.	Bluff	148,258
12.	Timaru	143,835
13.	Nelson	109,450
14.	Gisborne	109,008
15.	Piston	62,190
16.	Tauranga	58,708
17.	Onehunga	52,223
18.	Oamaru	46,553
19.	Thames	36,852
20.	Hokianga	22,251

It is quite obvious that the trade of Bluff is going to continually expand for a long time, probably in direct proportion to the increase of population of Invercargill and Southland, but what the rate of growth is going to be it is difficult to estimate. The Board must make provision for this increased trade, and care will have to be exercised that it neither builds too far in advance of requirements nor lags too far behind. The policy of the Board should be to plan for from 20 to 25 years ahead, and to start building operations about five years in advance of estimated requirements.

FINANCIAL POSITION OF BOARD.

Since its inception the Board's revenue generally has shown a steady increase, excepting in latter years, where fluctuations have been great owing to war disturbances.

Revenue started to drop from 1910 and continued falling until 1918, when there was a sudden rise. When one studies the wharfage dues figures, the fluctuation is not so great, and these dues did not start to fall until 1915, but rose again after 1918. From this I would estimate that the revenue of the Board will be about £40,000 by 1930.

I need hardly state that the Board's present financial position is sound. At the end of 1925 the Board's Loan indebtedness was only £31,600, and the total cash liabilities, including the loan, amounted to £35,592. Against this, the cash assets alone amount to £34,480. The Board's total assets exceed the total liability by £243,356. The Board's revenue for 1925 was £42,456, whilst the expenditure out of the ordinary revenue was £44,490, which included £8,446 for dredging, £9,815 for new wharf, £6,583 for new tug, and £1,200 for new plant. Of the above expenditure about £15,600 was for fixed charges, including administration, repairs and maintenance and interest on loans, leaving over £28,000 for capital expenditure.

It is fortunate for Bluff that at the end of a boom period and the beginning of a period of deflation, that it finds itself with no heavy debt obligations. Cost of doing work in the future is going to be considerably less than it has been in the immediate past. If we find ourselves in a period of depression, the Board's ability to be able to reduce charges if necessary will be appreciated by the various interests concerned.

As a return to the gold standard has been made in England, this must eventually bring down all values in New Zealand unless we adopt a different currency, which is not likely. For the immediate future, provided we can carry on the work out of revenue and still keep up with the requirements of the port, this policy should be adhered to within reason.

PROPOSED IMPROVEMENTS.

The most important work is the improvement of the entrance channel, and I recommend the Board to continue with this work until the entrance channel is at least 500 ft. wide and carries a depth for this width of at least 24 ft. at low water. This work will of necessity be very expensive. The scheme lays down the limits of the proposed channel, which is bounded on the north side by a straight line joining the No. 1 and No. 3 beacons. With this scheme there is a considerable area to be dredged in the vicinity of No. 2 beacon. The south side would be bounded by a line 50 ft. south from the north boundary and parallel to it. The obstructions on this side consist of a few groups of large boulders, on which blasting operations are at present being carried out. A couple of beacons will be needed to indicate the south boundary, and then this channel will be adequately marked. When these improvements are carried out, Bluff Harbour will possess a first-class entrance, safe and easy to navigate for vessels drawing up to 30 ft. at high water. Also smaller vessels will be able to work the port at any state of the tide. It must not be inferred from the above that the present entrance is not safe, but, as it is, it requires very careful navigation to avoid unnecessary risk. There will be no maintenance expenditure required for this channel. The next improvement is the completion of the dredging of the berths at the main wharf to a minimum of 30 ft. at low water. This work is at present being carried out. The maintenance and improvement of the approach channels and swinging basin to the main wharf is of the next importance. There will be a tendency for shoals to form in these places, and there will also be a tendency for the tail of the middle bank to reform, and this will necessitate some maintenance dredging at these places.

Provision is being made at the new wharf for a berth with a minimum depth of 30 ft. at low water. A doubt is expressed in shipping circles as to whether it will be practicable to berth large overseas vessels at this wharf on account of the difficult approach. I presume it was the Board's intention, when deciding to build this wharf, to eventually dredge the approach to same by, say, 24 ft. at low water. Until this is done it would be inadvisable to procure cranes for this wharf, but the rails for them should be laid or allowed for in the lay-out. With the completion of the new wharf, the berthage accommodation will be more than ample for present requirements.

CARGO HANDLING FACILITIES.

From my observation there is considerable delay in handling cargo at Bluff when there are two or three large overseas vessels at the main wharf, owing mainly to the difficulty of getting the railway trucks to and from the ship's side, there being an inadequate number of crossovers. The difficulty is not the lack of lifting appliances so much as getting the goods to and from the ship's side as quickly as the ship's gear can handle them. In modern ports, such as London, in the latest docks a vessel is able to discharge into lighters on both sides, into railway wagons, road vehicles and transit sheds all at one and the same time, so that the speed of loading or discharging a vessel depends entirely on the rate that the cargo can be stowed or broken out in the ship's holds. Undoubtedly the provision of transit sheds in conjunction with quay cranes capable of working the ships, and the flush decking of the main wharf would tend to more rapid cargo handling. I have given this matter careful consideration, and, unfortunately, I am unable to recommend the provision of such cranes on account of its lack of lateral stability. A lighter type of crane could be designed to handle goods placed on the wharf by the ship's gear. The provision of cranes on this wharf would mean the loss of one line of rails. Sheds could be built at the western end of the wharf by widening same on the inside, and the docking could be made flush. The mooring dolphins could be placed between the sheds and the wharf lights could be placed on them. The rails would have to be shifted to make room for the crane rails.

As this work would be very expensive and as portions of this part of the wharf are fairly old, I do not consider that the results to be obtained warrant the cost. The provision of transit sheds would postpone the necessity for extending berthage accommodation owing to the quicker despatch of vessels, therefore allowing a greater number of vessels to use each individual berth in a given time. One of the greatest needs of this port is storage accommodation so as to even up the flow of goods as between railways and ships. This is very noticeable when all berths are occupied, the delay in getting the goods to and from the ship's side then being considerable. This is not so apparent when there is only one vessel in port. Also the provision of transit sheds at Bluff will help to prevent the congestion at the Invercargill goods shed during the rush periods. Import goods could be rushed into the sheds from the ship's side and taken away as railway facilities offered. Export goods could be gradually accumulated without putting a strain on the railways, and rapidly loaded into the ship when it arrives. Also there would be steadier work for some of the waterside workers. This matter should be further investigated. In order to facilitate the handling of cargo on this wharf I recommend that the Board approaches the Railway Department and asks them to provide three more crossovers to the front lines of rails, and also asks them to contribute to the cost of installing and operating four electric capstans with necessary dummies. I understand it costs the Railway Department £400 per annum for houses for shunting purposes at Bluff. The exact position of these proposed crossovers and capstans would be fixed to suit requirements of Railway Department.

As an experiment, I recommend the Board to have a cargo mast or framework erected on the eastern end of the wharf, equipped with a one-ton electric hoist. The function of this mast and winch would be to work in conjunction with the ship's gear in a similar manner to the system known as "Burtoning," to enable goods to be landed on to or lifted from trucks on the second and third lines of rails. In other words, it would give the ship's gear a greater command of the wharf. Should this system prove successful, it may be possible to design sheds for the western end of the wharf incorporating these masts.

The lighting of the wharf is inadequate. The Board has 47 cargo clusters for hire to the shipping. When trucks are in the way, the lighting of the wharf at the ship's side is very poor. This can be overcome by lighting this area by means of clusters hung over the ship's side. The question arises as

to whether these lights should be free or otherwise. At present they are charged for.

The water supply is sufficient, but at times the date of delivery is slow owing to the small size of meters used. The pipes under the wharf will need renewing at an early date.

NEW WHARF.

I suggest that this wharf be widened on its inside and a transit shed about 60 ft. wide and 300 ft. long be erected. Customs examination facilities should be provided in this shed for passenger luggage, and the passenger traffic should be concentrated at this wharf. Provision could be made in this shed for the unpacking of motor cars at a special charge. Motor cars will be able to come right up to the ship's side and probably arrangements could be made with the Railway Department to take the railway carriages also to the ship's side, thus adding to the convenience of the travelling public. In order to facilitate the working of the shed it will be necessary to instal a couple of cranes on this wharf. A two-ton wharf crane, suitable to work overseas vessels, would weigh from 45 to 50 tons, and in its worst position would probably put a load of 18 to 21 tons on one leg. As the maximum concentrated load that this wharf will take is not more than six tons on the crane rail, nor more than twelve tons on the centre of the beams, it is doubtful whether it is strong enough to carry such cranes. Under-carriages can be designed so as to distribute this loading, and it is possible that a suitable crane could be designed for this wharf, or the lighter type of crane could be designed for it.

As an alternative, a couple of mobile cranes, either petrol-electric or electric battery type, such as manufactured by Messrs. Ransomes Rapier, Ltd., could be provided at a considerable saving in cost. These cranes would have the advantage that they could be used for other work, such as in the sheds and on constructional work. They have a capacity of two tons, and are one of the most useful types of general purpose cranes that I have seen.

With the widening and construction of the shed, this wharf could be considerably stiffened laterally so as to be better able to carry cranes.

In lieu of the capstans on this wharf I would suggest the employment of an electric storage battery truck, the truck to be capable of shunting railway trucks or of pulling a train of cargo trailers.

It is also proposed to use this wharf for the discharge of bulk oil. Water supply and electric lighting will be provided.

It is proposed to reserve the inside end of this wharf for the Stewart Island service and as a berth for the new tug. A small goods shed should be provided at this berth, and an area fenced off to facilitate ticket collection. The inside of the outer end of the wharf could be reserved for the discharge of fish, as it gives easy access to the cool stores.

FUTURE REQUIREMENTS.

To cope with the future requirements of the port the Board should have prepared and adopted a comprehensive scheme for harbour improvements. This should be submitted to the Marine Department for its approval, and steps should be taken to obtain further borrowing power. I have prepared, and submit herewith, a brief outline plan of such a scheme, which should be sufficient for a great number of years.

The basis of this scheme is a training wall or breakwater starting from above the oyster wharf and running in a N.E. direction on to the west bank, and then turning and running in an easterly direction until it strikes the main channel, and then turning with the main channel and running towards the present main wharf, leaving a 600 ft. entrance to the enclosed area, which would be free from tidal flow and liability to rapid silting. This wall would cut off the Ocean Beach channel, which would have to be diverted to join the main channel, as shown. The tidal flow of these two channels would then be concentrated to maintain better depth past the entrance to the enclosed area and past the main wharf on to the entrance of the harbour. Also it would tend to maintain the depths over the area to be dredged from the middle bank. Modern wharves equipped with the latest appliances could then be built within this area, and dredging carried out as required. The material dredged from this area could be used for reclaiming the area of land shown on the plan. Part of this land would be required for railway yards.

When there are indications that the present wharves will not be able to cope with the trade of the port, a start could be made with the new scheme, the first part of which would be the construction of the breakwater and the extra berthage required. As the present main wharf reaches a stage where maintenance charges become too heavy, it could be rebuilt on modern lines.

It will be time enough for the Board to consider any larger scheme of improvement when there are signs that this scheme is not sufficient for the port's requirements. This scheme will require careful investigation before it could be adopted. In any scheme adopted, provision should be made for a small boating harbour. This would add to the attractions of Southland, as Stewart Island is considered by a prominent Auckland yachtsman, who recently cruised around New Zealand, to be one of the finest cruising grounds in this country.

At the present moment harbour engineers find it very difficult to estimate the type and size of vessels to be catered for in allowing for future harbour works. It appears that at present the size of the vessels to be catered for is limited by the harbour accommodation available. At a conference of harbour engineers held in 1923, there was no agreement amongst them as to what the future developments of shipping might be, and some held that we would see cargo vessels in the future over 1,000 ft. long; some held that the best size was from 10,000 to 15,000 tons; whilst others predicted that a greater number of smaller vessels would be built. I understand that a couple of vessels are being built for the New Zealand trade that will require a depth of 40 ft. It may be many years before Bluff is called on to cater for such vessels as these, but the eventual aim should be for an entrance channel 600 ft. wide, giving 33 ft. at low water and provision for a modern wharf to give 40 ft. at low water. When trade conditions warrant it, these provisions can be made, but the expense will be heavy. I think it will be many years before the Bluff will be called on to cater for ships of a much larger type than at present catered for. If very large cargo vessels are put on to the New Zealand trade they will probably have to concentrate on three main ports, and possibly only on two, as the balance of the ports have not sufficient trade to warrant the high expenditure that will be incurred to make provision for these very large vessels. When the producers and consumers of the districts served by the smaller ports have to pay coastwise freights, it will be found cheaper to patronise the direct service with smaller steamers. Competition for trade in the future will be keen enough to ensure that overseas vessels will come direct to Bluff.

The improvement of the entrance of the Bluff Harbour will entail a large capital expenditure, but once the work is carried out there will be no maintenance expenditure required. It can be improved by stages, say, first aiming at an effective width of channel of 500 ft., and giving a minimum depth of water up to 24 ft. at low water, and then gradually increasing the depth up to 30 ft. at low water. Then, in the future, the effective width can be increased in stages until an ultimate width of 600 ft. is provided and the depth increased to give a minimum depth of 33 ft. at low water. Although this will involve a large total capital expenditure, the annual expenditure could be kept well within the Board's financial capacity, whilst at the same time the entrance to the port is gradually improving so as to eventually make it second to none in New Zealand. To effectively carry out the above work will require special rock-breaking and dredging plant, including barges costing about £100,000. This plant would replace the Board's present dredging plant and would be able to cope with the whole of the Board's dredging work.

Of a total area of over 3,200,000 acres of land occupied by Southland, more than half is unimproved land. Closer settlement and more intensive farming will increase production, and we can expect in the near future a much larger rate of settlement than in the past owing to there being better opportunities in Southland to-day for successful settlement than anywhere else in New Zealand.

Should the district demand that the port be developed along modern lines in anticipation of increased trade, it may be advisable to establish a rating area so as to relieve the possibility of having to make shipping charges too heavy at the beginning and thereby driving trade from the port.

ESTIMATES.

The following is a list of approximate estimates of the various items referred to in this Report:—

- Widening West end of Main Wharf and erecting three sheds—£67,000.
- Widening inside New Wharf and erecting one shed—£36,400.
- Capstans fitted (each)—£400.
- Wharf Cranes 2-ton full size, each, excluding cost of rails—£4,000 to £5,000.
- Cargo mast and winch (say, each)—£500.
- Wharf Cranes, 2-ton, small type (each, say), excluding cost of rails—£3,000 to £4,000.
- Two-ton Mobile Crane, say—£1,500.
- Electric Tractors (each, say)—£500.

PLANS.

The following plans were submitted:—

- "A."—Showing outline scheme for future development, Entrance Channel and approach to New Wharf.
- "B."—Main and New Wharf showing rails and proposed widening and Sheds.
- "C."—Cross Section East End of Main Wharf showing cargo mast.
- "D."—Cross Section West End of Main Wharf showing Transit Sheds and small type Wharf Crane.
- "E."—Cross Sections New Wharf showing full-size Crane and Transit Sheds.
- "F."—Diagram showing Revenue and Trade.

SIZE OF VESSELS.

In a Supplementary Report to the Chairman of the Board on November 5th, 1926, the engineer stated that since submit-

ting his Report on Port Facilities that information had been received that the Shaw, Savill and Albion Co. had cancelled its order for two 20,000-ton passenger liners for the New Zealand trade, and was substituting six 11,000 tonners for this trade. This action was taken on the score of economy. This would be an important point in considering the future policy of the Board.

PROVISION ON WHARVES FOR MOTOR TRANSPORT.

The engineer further stated that it would not be much use if the Board made provision for road transport unless a first-class road capable of carrying fast, heavy traffic were constructed between the port and Invercargill. Such a road would help more than any other item in removing the disability of having the port a considerable distance from the town. Warehouses and factories would then be brought within three-quarters of an hour of the shipping, with less handling and at a lower cost than at present and with less risk of damage. The improvement of this road would benefit the whole of Southland.

HARBOUR MASTER'S REPORT.

The Harbour Master, in a report on the question of approach to the new wharf, the type and size of vessels that can use it and other shipping relevant matters, stated that the approach to the wharf required great care and skill in berthing a vessel of any size. Foul ground, with rock bottom, extends for a considerable distance toward the channel from and beyond the end of the wharf as far as the lightship. A vessel of deep draught making for a berth at the new wharf must alter her course as much as 48 deg., which brings the current on her broadside.

At this position the vessel's speed must be reduced to a minimum, as she cannot overshoot her mark without fouling the wharf, and, with strong north-west or northerly wind, would run great risk of damage.

From the end of the main wharf there is a good depth of water for a distance of 400 ft. to near the end of the new wharf, which allows a small working margin for a vessel of 300 ft. length. The *Manuka*, 369 ft. long, twin screw, was berthed inside the main wharf under favourable conditions, but her departure with a fresh N.W. wind was a most risky operation although assisted by the tug. The s.s. *Karetu*, a single-screw steamer 310 ft. in length, has been berthed inside the main wharf, and the same risk occurred at her departure.

Until the approach has been cleared considerably, he was of the opinion that it would not be prudent to berth vessels there of a greater length than 310 ft. Until such work is done the new wharf will accommodate the smaller class of vessels and relieve the congestion which frequently happens with two or three large vessels at the main wharf.

In strong easterly weather there is considerable surge at the east end of the new wharf, and has been experienced by the Board's dredger moored there at different times. The western end of the wharf will be a good berth for the new tug, where barricades can be erected to control a crowd on excursion days and where the vessel would be in a sheltered position in any bad weather.

INSPECTING ENGINEER'S REPORT.

On March 29th, 1927, the Inspecting Engineer, Mr. H. H. Sharp, reported on the proposals as follows:—

The photograph shows the position of the new wharf and the foul ground which limits the area of approach; in addition to this I have shown the present engineer's suggested lay-out of wharves and remodel of the harbour arrangements throughout, somewhat on the lines indicated on the photograph.

I understand that when the Board decided to build this wharf they were in the position of either having to place the wharf in this position or else make a beginning with a complete new lay-out of wharves and remodel the harbour arrangements throughout, somewhat on the lines indicated on the photograph.

As it was only on a comparatively few occasions that the existing wharfage became congested, and as the trade of the Bluff was not growing very fast (Bluff being the port of entry and outlet for Southland purely and simply, and not likely to become a distributing port), the Board did not consider the time ripe for entering into a large loan liability to remodel existing arrangements when more limited facilities extensive enough for present conditions could be provided out of revenue.

Considerable capital has been made out of the fact that the soundings at the new wharf are comparatively shallow, but, as pointed out in my minute of 7th December last, it was always intended to dredge the berthage, and the dredging is already more than half completed, the special Lobnitz rock-breaking plant being employed for breaking up the bottom, which is then picked up by the dredge. It is anticipated that this dredging will be completed in six months.

Until the dredging indicated in red lines is carried out there will undoubtedly be risk in berthing large vessels at the wharf, but the Harbour Master considered that there is no difficulty in berthing smaller steamers, and this will then leave the main wharf freer for the inter-Colonial and overseas boats.

The Board also proposes to proceed with the dredging of the approach out of revenue as funds permit.

A new and up-to-date powerful tug is on order for this port, and is due for delivery very shortly; this also has a bearing on the subject of manoeuvring in restricted waters.

There is no doubt but that, before very long, the Board will have to go exhaustively into the question of remodelling the lay-out of the wharves and harbour generally; still, in the meantime, the new wharf will serve a useful purpose.

The Bluff Harbour Board have in the past guarded their finance very jealously, and are therefore now on a very sound footing, their loan indebtedness being practically nil. This being so, they are naturally unwilling to abandon their policy of carrying out improvement works slowly out of revenue in favour of a loan policy with rapid improvement to stimulate a trade which they are not sure is capable of any great expansion at present.

After carefully considering all the aspects of the matter, I do not consider that there is reason for the Marine Department to take any action. Actually, I consider that channel improvement is the most necessary work at this port and should precede any further large wharfage programme, beyond maintenance and possibly provision for shed accommodation.

Shipbuilding Developments.

Tyne Shipyard changes Hands.

It is announced that Sir W. G. Armstrong, Whitworth and Co., Ltd., have purchased the well-known shipyard of the Tyne Iron Shipbuilding Company at Willington Quay, Newcastle-upon-Tyne.

This step has been taken in order to increase the available accommodation for the building of the various types of mercantile vessels upon which the Company are now concentrating and for which they have many orders on their books.

The Willington Quay Shipyard has a history extending over three-quarters-of-a-century, and is able to claim the distinction of having built the paddle steamer *Star*, the first iron ship ever launched on the Tyne.

The first Diesel-engined oil tanker and the first Isherwood-framed vessel to be launched on the river were also products of this yard.

In recent years the yard has been thoroughly modernised and equipped with the most efficient plant and machinery for the construction of vessels up to 400 ft. in length and some 8,000 tons deadweight.

In normal years the yard employed about 700 men and produced an output of some 20,000 gross tons per annum and it is confidently hoped on Tyneside that under the control of Sir W. G. Armstrong, Whitworth and Co., Ltd., its past activities will be speedily revived, and that work will be found for an increasing number of men as new vessels are laid down.

The Company announce that active building will commence immediately necessary repairs and the installation of new machinery is completed under the charge of Mr. A. Thompson, M.I.N.A., who was previously manager for the Tyne Iron Shipbuilding Company.

Port Dues in Yugoslavia.

Prevailing Rates of Exchange.

The Department of Overseas Trade has received from the Commercial Secretary at Belgrade the following official rates of exchange for the payment of port dues in Yugoslavia during the month of January, 1928, which appeared in the *Official Gazette* of 31st December, 1927:

	Dinars.
1 Gold Napoleon	219.00
1 Pound Sterling	276.80
1 American Dollar	56.75
1 Canadian Dollar	56.40
1 German Mark (Gold)	13.57
1 Belga	7.95
100 French Francs	224.00
100 Italian Liras	303.00
100 Dutch Florins	2294.00
100 Roumanian Leis	36.00
100 Danish Crowns	1522.00
100 Swedish Crowns	1514.00
100 Norwegian Crowns	1511.00
100 Spanish Pesetas	950.00
100 Greek Drachmas	75.65

Personal enquiries regarding all shipping and transport matters should be made at the City Office of the Department (Shipping and Transport Section), 73, Basinghall Street, London, E.C.2.

Mercantile Shipbuilding in 1927.

Lloyds Summary shows Increase in Output against 1926

GREAT BRITAIN AND IRELAND.

During the year 1927 there have been launched in Great Britain and Ireland 371 merchant vessels of 1,225,873 tons (viz., 276 steamers of 865,472 tons, 80 motorships of 355,779 tons, and 15 barges of 4,622 tons).

With the exception of a composite yacht fitted with auxiliary engines, all these vessels have been built of steel, and not a single sailing vessel has been launched during the year.

The output for 1927 is 586,305 tons higher than that for the year 1926. The present total represents 53.6 per cent. of the world's output for 1927, as compared with 38.2 per cent. in 1926, 49.5 per cent. in 1925, 64.1 per cent. in 1924, 39.2 per cent. in 1923, and 58 per cent. in 1913.

NATIONALITY OF VESSELS LAUNCHED.

Of the tonnage launched during the year, 958,154 tons are for registrfation in Great Britain and Ireland, and 267,719 tons (21.8 per cent. of the total tonnage) are for owners residing abroad. This percentage compares with 14 per cent. in 1926, under 16½ per cent. in 1925, under 15½ per cent. in 1924, less than 3 per cent. in 1923, and an average of over 22 per cent. for the five pre-war years, 1909-1913. No less than 113,254 tons are intended for registration in the British Dominions overseas.

SIZE AND TYPE OF VESSELS.

The returns for 1927 show that 86 vessels of between 5,000 and 10,000 tons each and seven vessels of 10,000 tons and upwards were launched. The largest are the turbine vessels *Duchess of Atholl* (21,500 tons) and *Orford* (20,000 tons); the *Laurentic* (18,724 tons) fitted with a combination of turbines and reciprocating engines, and the motorship *Bermuda* (16,000 tons).

Excluding vessels of less than 1,000 tons, 62 vessels of 305,781 tons, for the carriage of oil in bulk were launched during 1927. Of these, 45 vessels of about 258,000 tons, and two other vessels of 7,830 tons, were built on the Isherwood system of longitudinal framing.

The tonnage of steamers fitted for burning oil fuel launched during the year amounts to nearly 300,000 tons.

The tanker tonnage represents nearly 25 per cent. of the total tonnage launched during 1927.

The returns include a number of vessels designed for Channel, coasting, fishing, towing, harbour service, and other special purposes.

The average tonnage of steamers and motorships launched during the year is 3,430 tons. If the vessels of less than 500 tons are excluded, the average is increased to 4,193 tons, as compared with 4,486 in 1926, 4,439 in 1925, 3,777 in 1924, 3,805 in 1923, and 5,186 in 1922.

VESSELS FITTED WITH TURBINES.

Further progress was recorded in the use of steam turbines during 1927, when 13 vessels with a total tonnage of 137,628 tons were launched which will be fitted with this method of propulsion. These figures include a vessel of 18,724 tons, which has a combination of steam turbines and reciprocating engines. It will be seen that the average tonnage of these vessels reaches the high figure of 10,587 tons.

VESSELS FITTED WITH INTERNAL COMBUSTION ENGINES.

The tonnage of vessels fitted with internal combustion engines is steadily increasing in comparison with the total output. The tonnage of such vessels launched during 1919 was 32,936 tons, while during 1925 it amounted to 267,217 tons, and to 201,913 tons during 1926. During the year 1927, 80 motorships of 355,779 tons were launched, this tonnage equalling 41.1 per cent. of the steam tonnage launched. The largest motorship launched during the year is the *Bermuda*, of about 16,000 tons, and it may be stated that of the 52 vessels of 6,000 tons and upwards launched during the year, 29 are to be fitted with oil engines.

OUTPUT OF LEADING PORTS.

The Clyde district occupies first place amongst the shipbuilding centres, showing an output of 423,723 tons. Then follow the Tyne (274,056 tons), the Wear (162,770 tons), the Tees (130,371 tons), Belfast (107,181 tons), and the Mersey (36,636 tons). The largest increase, as compared with 1926, has taken place on the Clyde, the figures for which are 156,078 tons higher than the previous year. The increase on the Tyne amounts to 147,447 tons, on the Wear to 127,583 tons, and on the Tees to 93,188 tons.

PROGRESS OF SHIPBUILDING DURING THE YEAR.

As regards the movement of the shipbuilding industry during the course of 1927, Lloyd's Register Quarterly Returns show that at the opening of the year 760,084 tons were under construction in Great Britain and Ireland.

The returns issued during 1927 showed a steady increase throughout the year, and on the 31st December, 1927, the tonnage under construction in Great Britain and Ireland only amounted to 1,579,713 tons, 819,629 tons more than twelve months earlier.

The figures for the end of 1927 are the highest recorded since September, 1922, but still show a reduction of 310,000 tons as compared with the average tonnage building during the twelve months immediately preceding the war.

It should also be stated that at the end of 1927 the totals only include 5,550 tons on which work is suspended, while at the end of 1926 such tonnage was nearly 100,000 tons.

OTHER COUNTRIES.

PARTICULARS OF TOTAL OUTPUT.

Attention is drawn to the statistics given in Table IV., from which it appears that there have been launched abroad during the year 431 merchant vessels of 1,059,806 tons (204 steamers of 510,356 tons, 174 motor vessels of 507,915 tons, and 53 sailing vessels and barges of 41,535 tons). The figures show an increase of 24,397 tons as compared with those for 1926, and a decrease of 4,464,301 tons as compared with 1919—the record year—and they are 340,923 tons lower than those for 1913, during which year the highest pre-war total was reached.

SIZE AND TYPE OF VESSELS.

The returns for the year include 33 vessels of between 4,000 and 6,000 tons each; 34 of between 6,000 and 8,000 tons; 16 of between 8,000 and 10,000 tons; and 12 of over 10,000 tons each, the largest being the turbine steamer *Cap Arcona*, of 27,561 tons, launched at Hamburg.

There were launched during the year 25 vessels of a total tonnage of 198,635 tons to be fitted with turbines. This total includes two vessels of 30,806 tons in which the turbines are used in conjunction with electric motors, and nine vessels of 36,215 tons which have a combination of steam turbines and reciprocating engines. Of the 25 vessels, four are of more than 10,000 tons each, the largest being the *Cap Arcona*, of 27,561 tons.

Excluding vessels of less than 1,000 tons, the output abroad for the year also comprises 19 vessels, of about 138,000 tons, built on the Isherwood system of longitudinal framing. Including 17 of these vessels of about 129,000 tons, there were launched during the year 37 vessels of about 237,000 tons for the carriage of oil in bulk. Of these tankers, 31 about 212,000 tons are fitted with oil engines.

During 1927 there were launched 174 vessels of 507,915 tons to be fitted with internal combustion engines, as compared with 169 of 502,093 tons in 1926. Fifty-nine of those launched during the year are of over 4,000 tons each, including seven of 10,000 tons and upwards. Of those exceeding 4,000 tons, 13 were launched in Germany, 10 in Sweden, nine in Holland, and eight in Denmark; the two largest being the *C. O. Stillman* of about 16,000 tons, built in Germany, and the *Christiaan Huygens* of 15,636 tons, built in Holland. The total figures for motorships include a few sailing vessels fitted with auxiliary power.

Of the steam tonnage launched abroad during the year about 170,000 tons are fitted for burning oil fuel.

The tonnage of wood vessels included in this year's total is only 17,273 tons, as compared with 14,753 tons in 1926, and 1,145,582 tons in the war year 1918, when the tonnage of wood vessels launched amounted to 28 per cent. of the total output.

With the exception of a training ship of 1,257 tons, built in Germany, and a schooner of 102 tons, built in Newfoundland, the totals for sailing vessels and barges (53 of 41,535 tons) are composed of craft which cannot be described as real sailing tonnage.

The countries where the largest output has taken place during the year under review are Germany, United States, Holland, Italy, Denmark and Sweden. The totals for these countries amount to 829,105 tons, and account for 78¼ per cent. of the total output abroad.

GERMANY.

During the year under review 105 vessels of 289,622 tons were launched. As compared with the output for 1926, the present figures show the large increase of 109,074 tons and represent 27¼ per cent. of the total output abroad during 1927, as compared with only 17½ per cent. in 1926.

These figures include 12 vessels of 78,676 tons to be fitted with steam turbines, including the largest vessel launched in the world during 1927, viz., the *Cap Arcona*, of 27,561 tons; the totals for turbine vessels comprise eight vessels of 35,115 tons which will have a combination of steam turbines and reciprocating engines. The total figures comprise, also, 33 vessels of 115,882 tons to be fitted with oil engines, the largest being the motor tanker *C. O. Stillman*, of about 16,000 tons. Four tankers, of 35,097 tons—all motorships—were launched.

The totals include 14 vessels of between 6,000 and 8,000 tons, four of between 8,000 and 10,000 tons, and three vessels of above 10,000 tons each.

UNITED STATES.

The output for the year 1927, namely, 179,218 tons, is 28,605 tons higher than during 1926.

Of the tonnage launched, 17 steamers and motorships of 82,754 tons and 30 barges of 24,800 tons were built on the Atlantic Coast, eight steamers of 54,948 tons on the Great Lakes, and 11 vessels of 16,716 tons on the Pacific Coast.

The largest vessels launched during 1927 were the turbo-electric vessel *California*, of about 22,000 tons, built at Newport News, and the motorship *Gulfpride*, of 12,510 tons, built at Kearny, N.J.; four other vessels of between 6,000 and 10,000 tons were launched on the Atlantic Coast; and one of 10,180 tons and four between 8,000 and 10,000 tons were launched on the Great Lakes.

Six turbine steamers of 54,916 tons were launched in this country during 1927, including two vessels, the above-mentioned *California* and one other vessel of 8,816 tons, both fitted with turbines in conjunction with electric motors. The motor tonnage launched amounts to 39,282 tons; of oil tankers of 1,000 tons and upwards, five of 37,318 tons were launched.

The totals also include five vessels of 39,261 tons built on the Isherwood system of longitudinal framing.

HOLLAND.

The total tonnage launched during 1927—119,790 tons—is 26,119 tons higher than the 1926 figures. As usual, the figures for this country do not include vessels exclusively intended for river navigation, the total tonnage of which vessels reaches a high figure.

Seven vessels were launched of over 6,000 tons each.

The totals for the year include 49 vessels of 86,194 tons to be fitted with internal combustion engines. Eight motorships are of 6,000 tons and upwards, the largest being the *Christiaan Huygens* of 15,636 tons, and the *Sibajak* of 12,040 tons.

Four motorships of 25,227 tons are intended for the carriage of oil in bulk.

ITALY.

The total figures for this country—101,076 tons—are 118,945 tons lower than those for 1926, which were the highest ever reached in this country. Eighteen vessels of 73,955 tons were launched in the Trieste district, as compared with an output of 94,136 tons during the previous year.

The totals comprise three vessels of 10,000 tons and upwards, the largest being the turbine steamers *Conte Grande* of about 22,800 tons launched at Trieste, and *Ausonia* of 13,500 tons launched at Genoa. Thirteen motorships of 49,698 tons were launched, the largest being the *Virgilio* of 11,920 tons, built at Baia, near Naples.

DENMARK.

The total tonnage launched during 1927—72,038 tons—is practically the same as last year, and is composed mostly of motorship tonnage (63,690 tons). Seven motorships of between 5,000 and 9,150 tons were launched; six of these, with a total tonnage of 44,501 tons, are intended for the carriage of oil in bulk.

SWEDEN.

The output for 1927—67,361 tons—is 13,843 tons more than that for 1926, and is the highest ever recorded in this country. Over 92½ per cent. of the total is composed of motor ships, of which eight are of between 5,000 and 7,000 tons each. The tankers launched—all motor ships— amount to seven, of 42,566 tons.

FRANCE.

The output for the year—44,335 tons—is 77,027 tons lower than that for 1926, and is the lowest recorded since 1919.

The total figures include one steamer of 9,950 tons, five motor ships of 17,076 tons, and six trawlers of over 1,000 tons each.

RUSSIA.

The shipbuilding activity in this country, which has been developing for the last two years, has resulted in the launching, during 1927, of 18 vessels of 43,917 tons. These figures include 10 motor ships, of 25,414 tons, one of which—an oil tanker—is of about 7,000 tons, and two are of 4,957 tons each.

JAPAN.

The output for this country—42,359 tons—is 10,046 tons less than that in 1926, and is the lowest recorded since 1910.

The 1927 totals comprise two motor ships, of 5,612 tons each, and two turbine steamers of about 4,280 tons each.

BRITISH DOMINIONS.

The total tonnage launched in all the British Dominions Overseas during 1927, namely, 30,250 tons, is slightly less than in 1926.

Of the total output, 23,773 tons were launched in Canada, including 10,131 tons on the Great Lakes.

The totals include two steamers, of between 6,000 and 7,000 tons each, launched at Levis, Quebec.

PROGRESS OF SHIPBUILDING ABROAD DURING THE YEAR.

Dealing with the combined totals for the work in hand in the various countries abroad, a large increase has taken place during 1927. At the beginning of the year the tonnage under construction amounted to 1,172,943 tons, and at the end of December the total was 1,539,008 tons, an increase of 366,065 tons. This increase, however, has not been general; while in some countries there has been a considerable addition to the work in hand, in other countries a large decrease has taken place.

The countries which show the largest increases are:—Germany, 261,233 tons; Sweden, 61,573 tons; Denmark, 56,568 tons; Russia, 33,238 tons, and Holland, 29,882 tons; while considerable decreases have taken place in Italy, 56,560 tons; United States, 54,265 tons; and France, 28,039 tons.

The returns for the fourth quarter show that at the end of 1927, the countries abroad having the largest amount of tonnage under construction are:—Germany, 472,295 tons; Italy, 183,216 tons; Holland, 173,887 tons; France, 115,029 tons, and Sweden, 100,700 tons.

The tonnage commenced during the fourth quarter shows a considerable decrease compared with the average figure for the previous four quarters, and would appear to indicate that, in general, the amount of work in hand in the shipbuilding yards abroad is not likely to show an increase within the near future.

SUMMARY OF WORLD'S OUTPUT.

The total output during 1927 has reached 2,285,679 tons. These figures represent the large increase of 610,702 tons as compared with 1926. As compared with 1913, during which year the pre-war world's record output was reached, the present figures still show a decrease of over 1,000,000 tons.

The output in Great Britain and Ireland represents 53.6 per cent. of the world's output during 1927, an increase of 15.4 per cent. compared with the similar figure for 1926.

Some interesting facts may be gathered as regards the special types of vessels and machinery included in the output of the year under review. The total launches comprise 38 vessels of over 336,000 tons to be fitted with steam turbines, including some vessels having a combination of steam turbines and reciprocating engines.

During 1927, 863,694 tons, have been launched in which internal combustion engines are being fitted. This tonnage compares with 704,006 tons launched in 1926. The present total is equal to about 62.8 per cent. of the world's output of steam tonnage, as compared with about 76 per cent. in 1926. It should be stated, however, that the tonnage of motor ships building in the world at the beginning of 1928 is actually 115,000 tons larger than the steam tonnage under construction, thus showing the sustained progress which is being made by this system of propulsion.

Of the total steam tonnage—1,375,828 tons—launched in the world, some 470,000 tons refer to steamers fitted for burning oil fuel under the boilers, so that the tonnage depending exclusively upon coal for propulsion only amounts to 39.6 per cent. of the world total for 1927.

The tankers launched during 1927 amount to 99 vessels of 542,437 tons, as compared with 246,000 tons in 1926.

It will be of interest to compare the total of the World Merchant Fleets in 1914 with the latest available figures. Disregarding sailing vessels and wood steamers, in view of their comparatively small importance in international trade, the gross tonnage of seagoing steel and iron steamers and motor ships amounted in June, 1914, to 42,514,000 tons, while at June, 1927, the figures reached 59,688,000 tons—an increase of over 17 million tons.

A remarkable change has taken place in the total tonnage of some types of vessels included in the above figures. For instance the tankers which in 1914 totalled 1,479,000 tons now amount to 5,916,000 tons; and motor ships which in 1914 only reached 234,000 tons now amount to 4,271,000 tons (including auxiliaries). A great change has also taken place in the relative use of coal and oil fuel for boilers. In 1914 the tonnage of the steamers fitted for oil fuel was 1,310,000 tons, while the 1927 figures show nearly 18½ million tons.

AN APPOINTMENT.

The Board of Sir W. G. Armstrong, Whitworth and Company, Limited, have appointed Lieutenant Colonel W. T. C. Huffam, O.B.E., M.C., their Chief Representative and Local Director in India, Burma and Ceylon with offices in Bombay.

CZECHOSLOVAK DANUBE TRAFFIC.

The traffic passing through the Czechoslovak Danube ports shows a considerable increase in the year 1927. Bratislava, with 536,000 tons, shows an increase of 22 per cent. as compared with 1926. The amount of traffic passing through the Port of Komarno has reached 78,000 tons, being an increase of 60 per cent.

Notes from the North.

A NOTABLE RETIREMENT.

" Recommendation that Mr. Thomas Monk Newell, M.I.C.E., Engineer-in-Chief to the Board, be retired as from the 2nd July next, inclusive, and that during the pleasure of the Board, he do continue with the Board as their consulting engineer." This motion by the Works Committee of the Mersey Docks and Harbour Board was adopted by the Dock Board at their meeting at Liverpool on January 5th. Mr. Newell was appointed in 1913, at a salary of £3,500 a year. Values have altered since then, and the salary is, of course, greater now. It is not yet known what figure will be attached to the new appointment, but it is a foregone conclusion that it will arouse world-wide interest.

By the end of June, Mr. Newell's great work in the design and construction of the Gladstone Dock will, it is expected, be completed with the exception of perhaps, one shed. The new Birkenhead Entrance Lock should be opened and in use, and the new inner entrance between the Alfred Dock and the East Float, finished, though the swing bridge across it will not be placed in position for some time after that date. With the execution of those two important extensions, the Works Committee felt that they would then have reached a point when they should pause and review the position.

Mr. Thomas Monk Newell, M.Inst.C.E., was appointed Engineer-in-Chief to the Mersey Docks and Harbour Board in succession to Mr. Anthony G. Lyster in January, 1913, and his chief work was the design of Gladstone Dock system. Mr. Newell joined the engineering department of the Dock Board in 1881 as a pupil of the late Mr. George Fosbery Lyster, father of Mr. Anthony Lyster, who, during the time he was Dock Board engineer, was responsible for the carrying out of great improvements on the dock estate. His career in higher positions began in 1889, when he was appointed chief assistant to the Hull Dock Co., and in 1899 he became chief engineer of the Company. Upon the absorption of the company by the North Eastern Railway Co., Mr. Newell was made chief dock engineer both for the extensive docks at Hull and the railway company's docks at Hartlepools and at Middlesbrough. During his official duties at these East Coast ports his abilities as a dock engineer were brought fully into play and he gained wide experience in dock construction and equipment, heavy dredging operations and river improvement works.

A REMINISCENCE.

Mr. Newell's retirement brings to mind that more than a century has passed since the appointment of the most famous of all Liverpool's dock engineers. It was in October, 1924, that Mr. Jesse Hartley was appointed engineer and surveyor by the Dock Trustees. He held the position for 36 years and was responsible for the construction of the major portion of the docks and river fronts as they exist to-day. The great walls of granite which keep the Mersey in bounds, were until recently referred to as " Hartley's Walls." A curious feature of Hartley's appointment was that his salary was not to be fixed until the expiration of his first year of service!

TUNNELLING THE MERSEY.

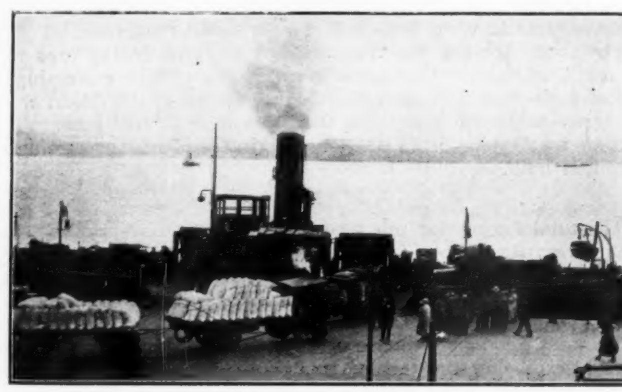
Borings under the River Mersey have made excellent progress and the new tunnel will be " through " in a few weeks. The engineers reported on January 11th that as much as 83.3 per cent. of the lower river heading and 76.2 per cent. of the upper river heading had been driven. Only 873 ft. separates the two faces of the bottom river headings and 1,243 ft. in the case of the top river headings. Out of a total length of 17,600 ft. included in the present contract, 13,700 ft. have been driven under both land and river, equal to 78.5 per cent. The estimated value of the work done is £405,519 out of a total of £718,079. On the Liverpool side, 1,506 ft. from the shaft, the cover of rock made it possible to dispense with the use of cast iron lining in the upper boring. The length here lined with cast iron has been 571 ft. The lower boring is driven in sound rock on the flat gradient under the middle portion of the river. A large shaft at Liverpool to be used in the construction of the full-sized tunnel, after the completion of the present headings (or borings) is being sunk. It is now some 95 ft. deep, which is almost 98 per cent. of its full depth. On the Birkenhead side, the river tunnel headings are proceeding in sound rock, with ample cover. Both headings have passed the bottom of the 1 in 30 gradient and are being driven on the flat gradient under the middle portion of the river. The 75 ft. length of full-sized tunnel continues under construction at the Birkenhead side, at a point some 400 ft. east of the Morpeth Branch Dock site, and is now some 75 per cent. complete. Progress continues on the Chester Street and Rendel Street approach headings at Birkenhead which are being driven in sound dry rock.

BROMBOROUGH DOCK SCHEME.

The work of constructing a new dock for Messrs. Lever Bros. at Bromborough is taking longer than had been planned. The time allowed by Parliament in 1923 for completing certain specified works will expire on July 31st next, and for completing the remainder of the works on July 31st, 1933. The contract for making and completing the dock was let on October 10th, 1924, and the works under the contract due for completion within three years, from the order of the engineers of the company to commence the works. This order was given on November 27th, 1924. It had become necessary for the Company (Lever Bros.), to serve notice on the contracting company calling upon them to proceed regularly and effectively with the works, but the contracting company neglected to comply with the notice. The company eventually terminated the contract on April 19th, 1926, and the contracting company is in course of being wound up compulsorily. By reason of this breach of contract, and the time required for arranging a new contract, the works have been much delayed, and it is declared expedient that the period granted by Parliament in 1923 should be extended. Messrs. Lever Bros. have, therefore, deposited a Bill in the Private Bill Office of the House of Commons to extend until October 31st, 1930, the time given for completing those works that " will not be situate above the level of 31 ft. above Liverpool Bay datum or form part of the return walls or embankments," and until October 31st, 1935, for completing the remainder of the works.

COLD STORAGE EQUIPMENT.

The Mersey Docks and Harbour Board has effected an important change in the cold storage plant at the Birkenhead Woodside lairages. There has been refrigerator accommodation here for the last 55 years and the Dock Board considered it timely that this should be thoroughly modernised. At



Birkenhead Goods Ferry, which was closed during the last two week-ends in January to enable certain necessary works to be done. The Traffic was transferred to Seccombe Ferry.

Birkenhead there will be an installation of three ammonia compressors of the latest type, coupled direct to electric motors which will take the place of three sets of absorption machines and plant, each of 100 tons refrigerating capacity, which have done cooling duty at Birkenhead abattoir for many years. The Dock Board has been actuated by the desire to make the meat handling facilities at Birkenhead as up-to-date as possible.

FLEETWOOD'S £100,000 SCHEME.

The L.M.S. Railway Company has made a start on a section of the large scheme of dock improvement and extensions at Fleetwood eventually to cost a hundred thousand pounds. Work has been commenced on the re-conditioning of the extensive old fish market stages, which are to be re-roofed and brought up-to-date, the intention being to use these as a standby when the fish dock is congested. It is probable that during the winter the Icelandic fish will be landed and dealt with here, while in the season, this will form a separate market for herrings. The larger portion of the scheme of dock improvements has been considered by the directors and it is probable that this will receive final sanction at a further meeting to be held shortly. The details of the scheme have, as promised by Sir Josiah Stamp, the President of the L.M.S., been laid before the fishing vessel owners and the fish merchants of the port, and agreed to by them, with modifications. The principal expenditure will be absorbed in the widening by 30 ft. of the stages occupied for the display of the fish after landing; the stage will then be 100 ft. in width. It is 2,000 ft. in length. This extension will necessitate the removal of several lines of railway metals. The lofts above the fish stage are also to be carried a storey higher.

PRESENTATION.

Mr. J. D. J. Saner, resident engineer for the Mersey Docks and Harbour Board on the Alfred Dock reconstruction scheme, Birkenhead, in connection with which an interesting engineering feat— the lifting of the old iron bridge in three pieces—was recently reported, has resigned the position to superintend a larger contract in the North of England. The esteem in which Mr. Saner is held by the foreman and workmen under his charge at the Alfred Dock reconstruction scheme was indicated when he was presented with a travelling bag, set of engineering books, and a wallet. Mrs. Saner was presented with a travelling bag and umbrella.